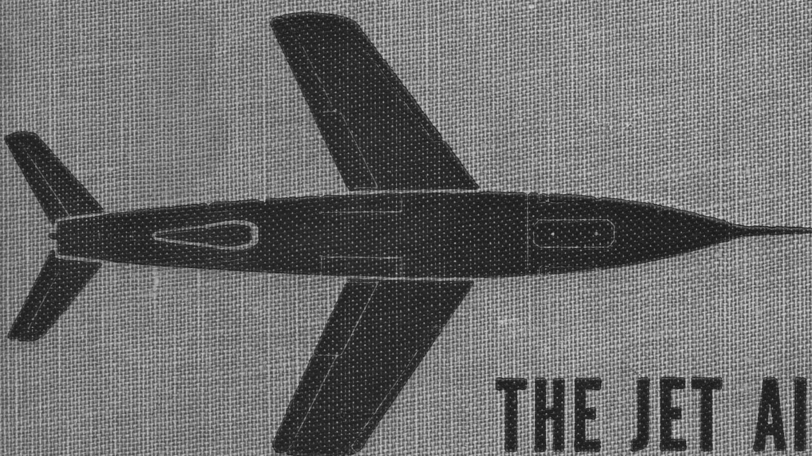

THE JET AIRCRAFT OF THE WORLD

THE JET AIRCRAFT OF THE WORLD

by *William Green* and *Roy Cross*

This is the most comprehensive and most authoritative book ever written on jet aircraft and the history of jet propulsion. Containing over 600 high-quality photographs and almost 200 three-view identification silhouettes, THE JET AIRCRAFT OF THE WORLD illustrates and describes in detail every jet built and flown to date.

The history of aviation has seen few technical advances more dramatic than that of jet propulsion. In the short space of fifteen years this new concept of powered flight has completely eclipsed the piston engine and has brought about a major revamping of aircraft structures and designs. This book gathers together for the first time in one volume the complete picture of this startling progress in flight.

There are hundreds of jet aircraft from all parts of the world covered in this volume, including many little-known Russian models. Each is arranged in chronological order to show the step-by-step evolution of today's supersonic research, combat planes, and commercial jet aircraft. For each major type, whenever possible, there is a photograph of the actual plane, a three-view identification silhouette, a brief history of development, plus all available data on specifications, performance, and armament.

An important feature of this book is the presentation of thirty of today's most important and newest aircraft in the form of full-page, photographically accurate, four-view tone drawings. These drawings show each aircraft in superb detail with—in the case of military aircraft—typical war loads. The essence of these special drawings and the numerous photographs and official drawings serves as a graphic comment on the progress in design and development of today's modern aircraft.

THE JET AIRCRAFT OF THE WORLD is up-to-date and complete in all respects. It also contains sections devoted to the various forms of jet propulsion, jet helicopters, and jet engine test beds. These unusual and informative sections combine with the many other features briefly outlined above to provide all those who are interested in aviation with the most indispensable reference guide ever to be compiled on jet propulsion.

William Green and Roy Cross

The Jet Aircraft of the World

Three-view line drawings by
Norman Blackburn and Ian Huntley

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Contents

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Introduction

THE trend towards turbine engines for both military and civil aircraft has now reached a stage where nearly all military aircraft are jet propelled and a growing proportion of civil aircraft are being powered by one or another form of turbine. Although ramjet-driven and rocket-propelled aircraft are still widely regarded as *novelties*, their era is fast dawning. Yet, in this age of great technological advances, with aviation spectacularly to the fore, we tend to forget that what has been achieved in aircraft propulsion in recent years has merely been the development of early ideas and their application through increased mechanical efficiency.

Hero of Alexandria experimented with a reaction turbine which he called an *aeropile* some two hundred and fifty years before the Birth of Christ, and experiments have been conducted with the energy of moving gases ever since. Rocket-driven missiles were used by the Chinese against the Mongol armies of Kublai Khan in the thirteenth century; in 1780 Hyder Ali, Maharajah of Mysore, used the rocket against opposing British forces, and rocket missiles were used with success by Colonel Sir William Congreve in the bombardment of Boulogne and Copenhagen and materially assisted in the capture of Danzig in 1813. Various methods of jet propulsion were patented in Britain some seventy years ago and, in 1894, Sir Hiram Maxim of machine-gun fame built an aeroplane driven by steam which actually left the ground. In 1910, the Coanda biplane employing a ducted-fan type of turbine was exhibited in the Paris *Salon Aeronautique*, and in 1913 the principles of the ramjet were propounded in *L'Aerophile* by Monsieur Lorin.

But it was not until the 'thirties that jet propulsion began to offer serious possibilities as an aircraft prime mover. It had no *inventor*; it was the outcome of research and experiment which had been commenced spontaneously and independently in several countries. In Britain, Air Comm. Sir Frank Whittle and Dr. A. A. Griffith were the most prominent among the early pioneers; their German counterparts were Hans von Ohain and Max Adolf Mueller, and in Sweden, A. J. Lysholm was responsible for much pioneering work. In Germany, Paul Schmidt developed the pulse jet and Dr. Eugen Saenger and Dr. Otto Pabst conducted considerable research with the ramjet, as did also Rene Leduc in France. Secondo Campini worked on ducted-fan type units in Italy, and Wernher von Braun developed liquid-fuel rockets in Germany. By the end of 1939 both turbojet and rocket propulsion had been successfully applied to aircraft. Since then the metamorphosis in aircraft design brought about by the new prime mover has been truly remarkable.

Turboprops, turbojets, ducted-fans, pulse jets, ramjets and rockets, the variety of aeronautical power plants embraced by the word "jet" when used in its widest sense is fast becoming bewildering to those who are not actively concerned with the subject. In the first section of this book we have endeavoured to explain in simple terms the differences between the main types of gas turbine, the pulse jet, ramjet and rocket. Subsequent sections present as briefly as possible the modern history of jet propulsion. The jet engines developed in each country are listed and the multifarious aircraft types that they have powered are each described in turn. No attempt has been made to be interpretive. With but few exceptions (these being restricted to the Lockheed XF-104 single-seat interceptor fighter which flew in February, 1954, but concerning which no details have yet been revealed, and some of the experimental and service aircraft which have been developed in the U.S.S.R. and which no authoritative information is available), all "jet" aircraft flown to date are included.

The aircraft are described in the chronological order of the first flight by gas turbine, rocket or ramjet of the prototype. Certain types of particular note are described in greater detail; generally, these are in the widest use, or are considered to be representative of particular phases in jet aircraft design. The tone general arrangement drawings which illustrate them sometimes include side views, to the same scale for purposes of comparison, of variants of the main design. In each case the plan view is divided down the centre line to show on one side

the underneath view, and on the other the top view of the *same* portion of the aircraft.

The majority of jet engine flying test-beds are illustrated in the section devoted to jet engine development, as are also the several types of combat aircraft which, primarily powered by piston-engines, employ turbojets for take-off and combat boost.

In conclusion, we would like to express our thanks to our good friend *Chronicler*—which pseudonym hides the identity of a well-known aeronautical writer—for his valuable advice, encouragement and active assistance in unearthing little-known facts; to Gerald Pollinger who has spent innumerable hours reading galley and page proofs, checking facts and figures and compiling the index; to those superb aircraft photographers and indefatigable collectors of the rare and obscure in aircraft genealogy, Warren M. Bodie and Howard Levy; to our German friends, Gert W. Heumann and Heinz J. Nowarra, and to aircraft manufacturers throughout the world who have co-operated so readily in furnishing information and illustrations for inclusion in this book. Lastly, we particularly wish to record our thanks to Norman Blackburn and Ian D. Huntley in whose capable hands was left the considerable task of preparing the numerous line drawings which illustrate the *Propulsion Simply Explained* and *Aircraft* sections of the book.

We wish to stress that no information contained in *The JET AIRCRAFT of the World* relating to British combat aircraft and jet engines currently included on the official *Initial* and *Part Publication* Lists, other than that made publicly available, has been obtained from official sources. All approximate performance figures, thrust ratings, etc., quoted for such aircraft and engines should be treated as *estimated figures*, representing personal research and assessment based on publishable facts and reasonable conjecture, and *not* of official origin. Data stated to be quoted from foreign sources has not necessarily been officially confirmed and should also, therefore, be treated only as a general guide to the performance capabilities of the aircraft or turbojet concerned.

London, January, 1955. THE AUTHORS

JET PROPULSION SIMPLY EXPLAINED

The term "jet propulsion" covers four basic types of aircraft power plant: the gas turbine, the rocket engine, the pulse jet, and the ram jet. Examples of the use of all these types of power plant are described and illustrated in this volume, and the story of their development in various countries is told on pages 11 to 31.

The fundamental principle of jet propulsion, upon which all four types of engine depend, can be understood if one thinks of a fireman's hose in action. Water pumped along the hose at pressure exhausts through a nozzle. This possesses a tapering cross section which increases the velocity of the water into a high-speed jet.

The reaction, or push backwards, that the fireman feels on the nozzle, is a direct result of this speeding-up action. This push or thrust is in fact so great that the fireman has to fight to keep the hose and nozzle under control. The thrust, we note, acts in the opposite direction to the jet of water, and is not increased or in any way affected by what happens to the water after it leaves the nozzle. The thrust is the same whether the water jet is directly hitting a wall, or is directed up into the air—that is to say, there is no pushing effect passed back up the water jet to the fireman.

We can now apply this principle to jet propulsion, and consider an open-ended tube, with air taken in at the front at the airspeed of the aircraft. The initial part of the tube is of increasing area, which is the converse of the hose nozzle and causes the air to slow down and, therefore, its pressure to rise.

Once the air is in this pressurized state, fuel is burnt in it. The heat produced raises the overall energy content of the air—or, more accurately, the combustion gas. This gas then exhausts to atmosphere through a nozzle at the rear end. Because the gas has greatly increased energy, it leaves the rear of the tube much faster than the air entered at the front. In other words, it has been speeded up and—like the water in the fireman's hose—produces a thrust. This is used to propel the aircraft forward.

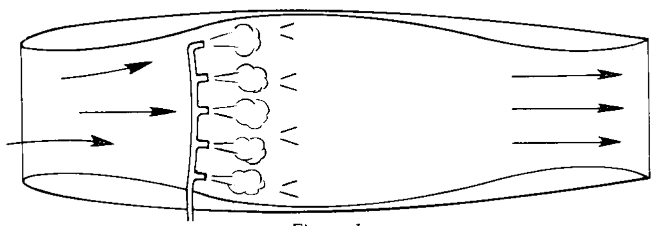


Figure 1

A simple straight-through arrangement such as we have just described, with the fuel supply and ignition equipment as the only internal parts, is known as an **aero-thermo-dynamic-duct** (athodyd for short), or **ramjet** (Fig. 1). A moment's thought will show that it can work only when it is moving forward at a fairly considerable speed, so that air is "rammed" into the intake in sufficient quantity to produce combustion at the required rate and therefore produce the required thrust. A ramjet cannot be started when it is stationary.

This consideration means that the ramjet has not been widely adopted for aircraft propulsion, it being necessary to launch the ramjet aircraft from a parent aeroplane, or by means of a take-off booster. For guided missiles, which can easily be ramp-launched with jettisonable solid-fuel rockets, its simplicity, cheapness and small size make it particularly suitable.

The same disadvantage is not found in the **pulse jet**, where a series of valves is fitted across the inlet. Fuel is injected into the combustion zone, as in the ramjet, and is ignited. The resulting explosion drives the exhaust gases out of the rear of the pulse jet; they are prevented from going forwards by the valves which are of the one-way type (Fig. 2).

When all the gases have been expelled from the tube, a depression occurs inside the pulse jet. This permits atmospheric pressure outside to open the valves to admit more air to the combustion zone (a little air may also enter from the back). After a further explosion, the whole cycle repeats itself. The repetition of explosions reaches a high frequency; the Argus pulse jet on the German Fi 103 flying-bomb, operated at 2,800 cycles per minute.

Once again, because of the heat energy added to the air, the gases leave the nozzle of the pulse jet—which may be of slightly reduced diameter, much faster than the air enters at the front. Thrust is therefore produced. When the aircraft or missile is airborne and travelling at reasonable forward speed, any tendency for air to enter through the rear ceases.

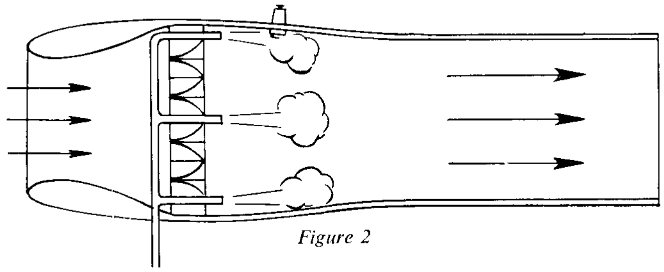


Figure 2

An interesting variation of the pulse jet is represented by certain French units, which by special design of the inlet profile, avoid the use of the mechanical one-way valves. They have what is known as an aerodynamic valve which lets the air enter very readily but "resists" any tendency for the exhaust gases to flow out forwards.

THE GAS-TURBINE FAMILY

Although the pulse jet and ramjet engines have been described first to maintain a logical sequence of explanation, these two types of jet propulsion have limited uses—as a glance at the contents of this book will show. It is the gas-turbine aero engine which has been responsible for the revolution in aircraft design since 1940.

In general terms, the gas turbine consists of a compressor which is driven by a turbine mounted on the same shaft. The air from the compressor, at six or seven times atmospheric pressure, enters a combustion chamber system where fuel is burnt with it. The combustion gases then pass through the turbine, thus driving (turning) it, and then through a nozzle at the end of the tail pipe and so to atmosphere.

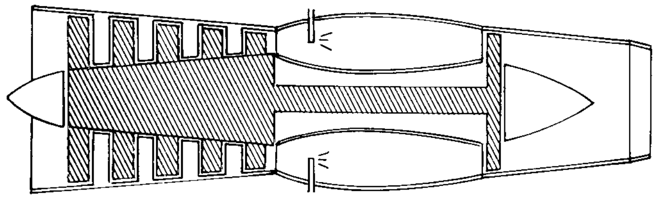
Compressors may be of two basic types—centrifugal or axial. A centrifugal compressor normally comprises a single impeller. Air from the intake is fed to the centre and is speeded up by being thrown outwards by centrifugal force. It is collected round the outer rim of the impeller by a diffuser, which slows it down and increases its pressure before it is fed into the combustion chambers.

An axial compressor comprises several rows or stages of carefully designed aerofoil-shape blades, the alternate rows of which rotate on the common shaft with the turbine. As the air passes through each stage it is compressed further, and then passes directly into the combustion chamber from the last stage. Although more difficult and expensive to build than a centrifugal compressor, the axial type can give higher pressure ratios and this has led to its adoption for all important high-powered gas-turbine engines today.

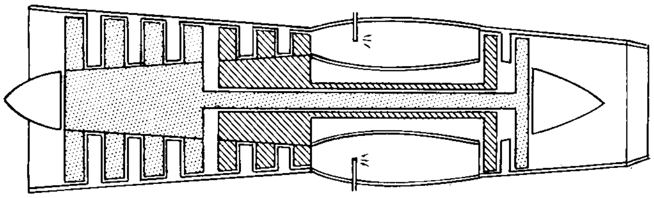
The energy produced by combustion of the compressed air and fuel—which is normally kerosene (paraffin) but may be almost any petroleum fuel including aviation petrol, diesel fuel oil, etc.—is considerably in excess of that required by the turbine to keep the compressor spinning. In the **turbojet** the turbine wheel—a disc with aerofoil blades mounted round the rim—is designed, therefore, to absorb only the required amount of energy, and the remainder is available as propulsive energy.

The simplest form of turbojet is as already described, with a single shaft mounting either an axial or a centrifugal compressor and the turbine disc, with the combustion system between (Fig. 3). A refinement which has made its appearance more recently is the **two-spool** or **double-compound turbojet,** which has two quite separate but co-axially mounted compressor/turbine assemblies to permit a higher pressure ratio and therefore lower fuel consumption to be achieved. In this type of engine the compressor is split into two units, low and high pressure, and each is powered through co-axial shafts by its own turbine disc, which may itself be of several stages (Fig. 4).

The thrust of the pure turbojet can be increased by various means, the most popular of which are water injection and



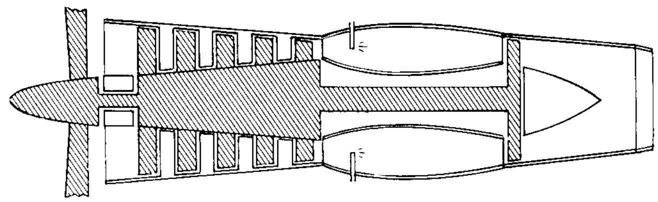
(Above) *Figure 3* (Below) *Figure 4*



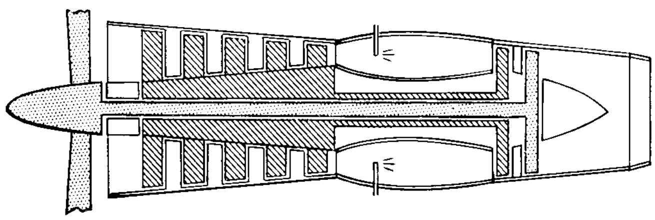
afterburning or re-heat. **Water injection** permits a fairly small increase in thrust without undue weight penalty, and is particularly useful for take-off. **Afterburning,** which consists of injecting fuel into the jet stream behind the turbine and burning it there with the oxygen that remains unused after the combustion in the main engine, gives larger thrust increases—up to 25 or 30 per cent and reaching 70 per cent at high speeds—and is used primarily in military aircraft for take-off and combat boosting.

If it is required to utilise the power of the gas turbine to drive a propeller, in the **turboprop** arrangement (Fig. 5), then the turbine assembly must be designed to absorb not as little power as possible but as much as possible. The propeller is mounted at the front end of the compressor/turbine shaft, with the necessary reduction gearing, and is driven by the excess of power over the compressor requirement.

Like the turbojet, the turboprop can use an axial or a centrifugal compressor. A further common variation is to divide the turbine into two units, one of which powers the compressor and the other the propeller: these turbines are entirely independent but on co-axial shafts. This is known as the **free-turbine** layout (Fig. 6).



(Above) *Figure 5* (Below) *Figure 6*



The two-spool turbojet also has its counterpart in the **supercharged turboprop** (Fig. 7). This type of engine is designed to provide constant power output over a wide altitude range—sea level to 25,000 ft.—and a wide temperature range. It comprises a high-pressure compressor, combustion chambers and H.P. turbine as the gas-producing unit, which delivers power to a low-pressure turbine, which not only drives the propeller but also powers a low-pressure compressor. The L.P. compressor is in front of the H.P. unit and supercharges it. There is no mechanical connection between the L.P. and H.P. sections of this type of engine.

Another variant of the gas turbine which has been applied to aircraft propulsion is the **ducted-fan** (Fig. 8). This gives an increase of propulsive efficiency by dilution of the hot exhaust stream leaving the turbine. The engine is basically of the turbojet type, but the turbine disc is redesigned to carry a series of fan blades at its tips. The fan blades are virtually a short-bladed propeller.

The engine nacelle is so designed that additional air is taken in around the compressor/combustion system and passes

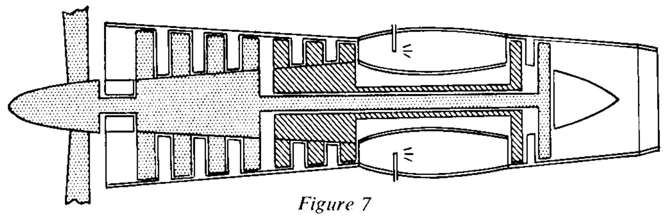


Figure 7

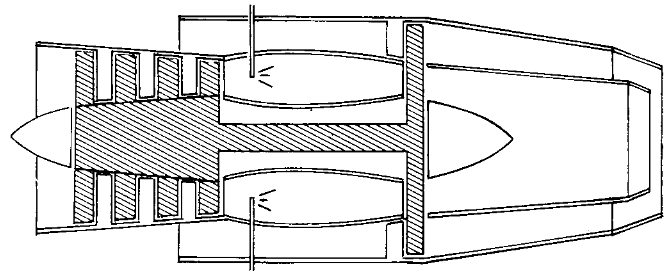


Figure 8

through the fan blades. It later becomes mixed with the hot gases passing through the inner part of the turbine and so augments the jet exhaust gases.

A further variant of the ducted-fan is the **by-pass** engine (Fig. 9), which achieves a similar result in a rather different way. The by-pass engine uses an oversize compressor, and the air flow is split after passing through the compressor. Up to 80 per cent of the air passes through the combustion system and turbine in the usual way, and the remainder is by-passed direct to the jet pipe, where it is mixed with the hot gases.

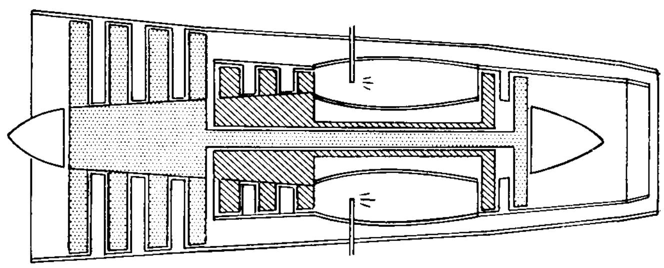


Figure 9

ROCKET ENGINES

The principle of rocket propulsion is very similar to that of the systems already described. However, instead of taking in atmospheric oxygen, using it in combustion and accelerating the gases out of the back, the rocket engine carries tanks of propellant which undergo a chemical reaction in a combustion chamber and make it independent of an outside source of air. The pressure of the gases so formed forces them out through a nozzle at high velocity. This speeding up of the gases, as with the water through the fireman's hose, gives the necessary propulsive thrust.

The rocket engine therefore does not need air for its functioning, in fact the higher the altitude at which a rocket is used, the greater its thrust, because of the lower atmospheric pressure. However, because of the rocket's extremely high propellant consumption, all of which must be carried in the aircraft, endurance is usually restricted to several minutes only.

There are two types of rocket engine, defined by the type of chemical reaction produced by their propellants. With a monopropellant, such as hydrogen peroxide (H.T.P.), there is only the one propellant. This reacts with a catalyst, and then decomposes at a not very high temperature into steam and oxygen. These two accelerate through the nozzle to produce thrust. Because of the fairly low temperature, these units are referred to as "cold" rockets.

The second type has two propellants—one a fuel and the other an oxidant—which provide the oxygen necessary for combustion. Typical combustion combinations of fuels and oxidants are kerosene and liquid oxygen, aniline and nitric acid, or kerosene and hydrogen peroxide. These pairs of propellants are ignited and combustion takes place at high temperature—hence their name of "hot" rockets.

THE DEVELOPMENT OF AIRCRAFT JET ENGINES

ALTHOUGH the principle of jet propulsion has been known for at least 2,000 years, having been demonstrated by Hero, the Alexandrian philosopher, with his aeropile, its practical application has had to wait. Not until the present century has it become possible to match in practice the demands of the inventors who, down the ages, have dreamed of jet propulsion in various forms as a motive force.

The gas turbine was first successfully developed as an industrial power unit, but its application to aircraft, in the form of turbojet and turboprop engines, owes little to this earlier work. Early industrial and aircraft gas turbines had little in common other than the principle of operation, and the engineers of various nationalities who initiated aircraft gas-turbine development were creating a new power source rather than modifying an existing one.

Who was first? No simple answer can be given to that question, but in the pages which follow, the development which went on in each country is traced in some detail from its beginnings. It will be seen that work began spontaneously and independently in several countries between the two world wars, though few of these lines of development have survived to the present day.

Britain and Germany had made the most solid progress by the time war broke out in 1939, and it is of interest to note that in both these countries two quite distinct lines of development were being followed independently up to the time government interest was aroused and a co-ordinating policy formulated.

Although the work in Germany started rather later than in Britain, the world's first successful jet flight using a gas-turbine engine was made in Germany almost two years before the first British jet aircraft flew, and a German rocket-propelled aircraft was flown with some success even earlier.

Apart from the work in Germany and Britain, note should be taken of these other events: in Sweden, Lysholm had patented gas turbines of his own design in 1933 and a small turbojet was tested as early as 1934; in France, Leduc had been experimenting with ramjets since 1929 and was building a ramjet aircraft by 1940; in Hungary, Jendrassik built and successfully ran an aircraft turboprop in 1941; and in America two aircraft manufacturers were giving serious attention to jet propulsion by 1940. With the exception of the Leduc experiments, however, which have been pursued with success since the war, none of these developments has been continued.

Today, every nation supporting a major aircraft industry is working on aircraft jet-propulsion engines, and few established aero-engine manufacturers in these countries have not turned their attention from piston engines to the new prime mover. In the review which follows, the development of aircraft jet-propulsion engines is traced country by country; it is a factual account of the engines built and does not attempt to be interpretive.

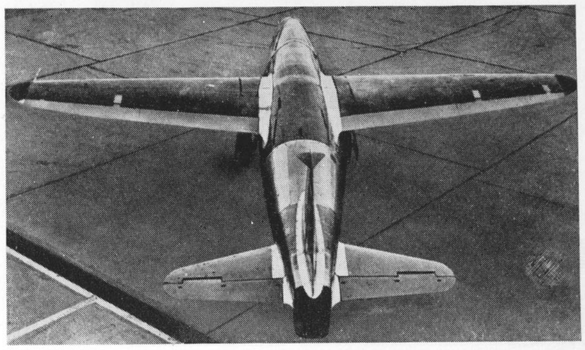
GERMANY

German jet-propulsion engines derive primarily from two independent lines of development initiated at about the same time by the Heinkel and Junkers aircraft manufacturing companies (the latter being distinct, at that time, from the Junkers engine company). Both these developments were private ventures from 1935 until 1939, in which year government support was offered to the existing piston-engine manufacturers in Germany if they would undertake gas-turbine development. Thereafter, Heinkel continued jet-engine development for a time in the face of strong opposition, which he eventually overcame; the work of the Junkers airframe division was absorbed by the engine company; and B.M.W., Bramo and Daimler Benz came into the picture.

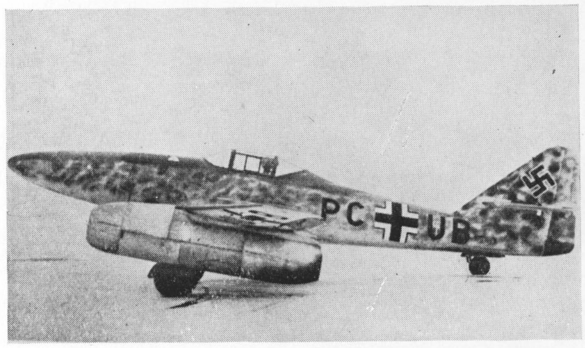
Various other work was also going on in Germany from an early date, including the pulse-jet development by Paul Schmidt and the study of rocket motors. The latter work is described below where it is applicable to aircraft, but the work of von Braun and others at Peenemünde and elsewhere, which produced the A.1 to A.9 series of rocket missiles, is outside the scope of this review.

HEINKEL

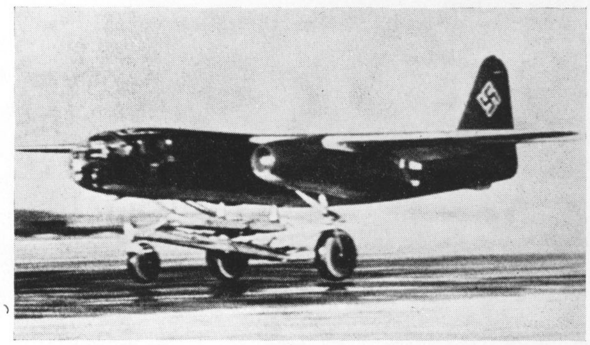
This company began work on a gas-turbine engine for aircraft propulsion in February 1936 when Hans von Ohain, a student at the University of Göttingen, was taken onto the staff to develop an engine of his own design. This engine, as patented, resembled in general, but not in detail, that shown in Whittle's first patent of 1930, but in fact it owed nothing to Whittle's design. Von Ohain built a demonstration engine, the HeS 1, and had it running by March 1937, giving 550 lb. s.t. Work then proceeded



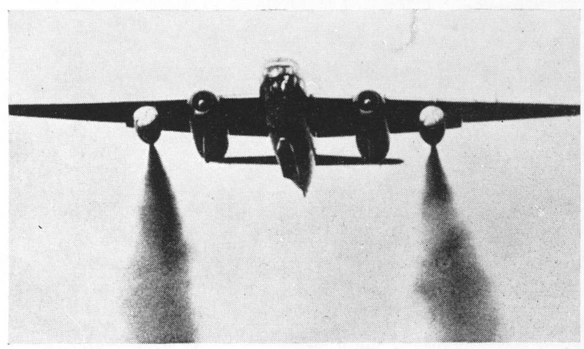
(Above) *The He 178 used to test the HeS 3B and HeS 6 units.*
(Below) *The Me 262 V-2 flown with the Jumo 004A in July 1942.*



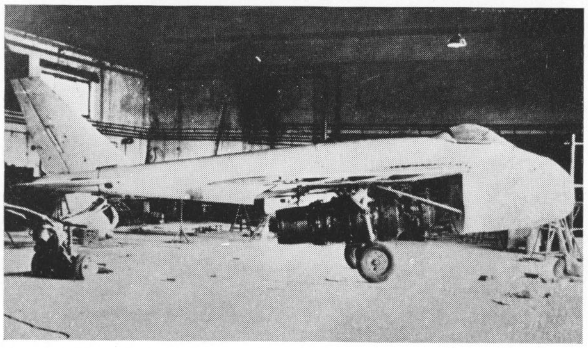
(Above) *The Me 262 V-6, the first prototype with Jumo 004Bs.*



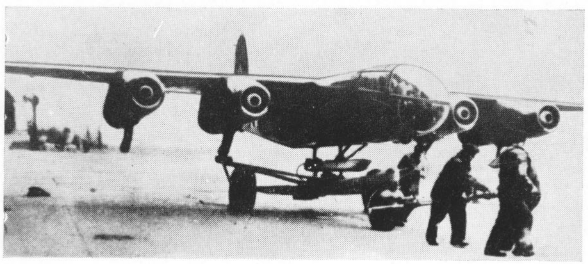
(Above) *The Ar 234 V-1s first take-off with Jumo 004A units.*
(Below) *The Ar 234 V-3 taking off with B.M.W.109-501 rockets.*



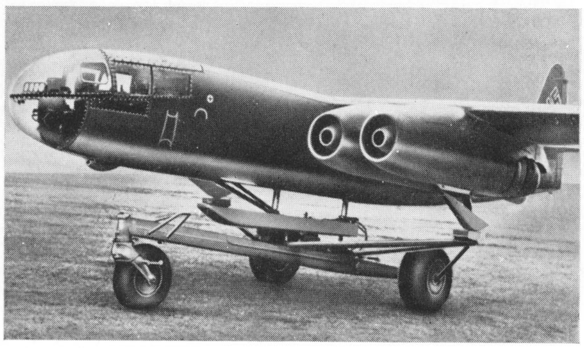
(Above) *Ju 287V–1 with Jumo 004Bs and Walter 109–501s.*



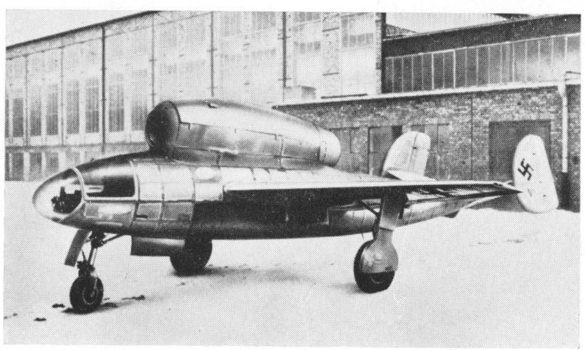
(Above) *The Messerschmitt P.1101 with Jumo 004B turbojet.*



(Above) *The Ar 234V–6 with four B.M.W. 003A–1 units in single nacelles and* (below) *the similarly-powered Ar 234V–8.*



(Below) *Henschel Hs 132V–1 dive-bomber with a B.M.W. 003A.*



on a flight engine, the HeS 3, and at the same time Heinkel began design of a fighter prototype to take advantage of this engine.

The first flight engine, tested in 1938, was not a success, but it was redesigned as the HeS 3B, which delivered 1,100 lb. s.t. and, installed in the He 178, made the world's first true turbojet flight on August 27, 1939. In a further development of this engine, the HeS 6, thrust was increased to 1,300 lb., and this engine was also flown in the He 178 before development was discontinued.

Having thus proved his point, Heinkel finally obtained official support for his work late in 1939, by which time the government was sponsoring jet-engine development by other aero-engine manufacturers. Work was now concentrated upon the HeS 8, another von Ohain centrifugal design, based on the HeS 3, but of smaller diameter and delivering 1,320 lb. thrust, and the axial HeS 30 and HeS 40, which had originally been designed by Mueller at the Junkers airframe company before he joined Heinkel. These two types of engine were designated, respectively, the 109–001 and 109–006.

Intensive development of the 109–001 continued until September 1942, when it became clear that the centrifugal engines had been outstripped by the axial types, and further work on this type was stopped. It was flown with some success in the first half of 1942 in an He 280, giving 1,100–1,300 lb. s.t., but an attempt to fly an Me 262 with two 001s failed because of their inadequate thrust.

The 109–006 was for its time an extremely advanced axial design and first ran in the spring of 1942; by the end of that year it was giving nearly 1,900 lb. for a weight of 857 lb.—the best German achievement at that time. Despite this fact, however, Heinkel was forced to drop its development late in 1942 in order to concentrate on another new engine, the 109–011.

Work on the 109–011 (HeS 11) began, to an official request, late in 1941, and von Ohain was put in charge. It was to give 2,460 lb. initially and 3,520 lb. eventually. To expand his engine facilities, Heinkel acquired the Hirth Motoren works at Stuttgart, moved Mueller and the 109–006 project there, and left von Ohain to concentrate on the 109–011 at Rostock.

Five experimental 011 engines were built during 1943 and five more in 1944, but by the end of the war, only a few flights had been made, on a Ju 88 test-bed, and none on the power of the 011 alone. A turboprop version, the 109–021, had also been planned originally, and was taken over by Daimler-Benz in the autumn of 1943.

JUNKERS

Original Junkers work, beginning in 1936, was done, like Heinkel's, as a private venture by Max Adolf Mueller of the airframe company, having been initiated by Herbert Wagner, chief of airframe development. First thoughts were for a turboprop, but studies were extended to cover turbojets and piston-engine ducted-fans, and by 1938 work was concentrated on an axial turbojet. This had some advanced features and a notably low diameter and weight, and was running on the bench by 1938.

About the same time, serious work began on a turboprop, and a mock-up was prepared of a ducted-fan driven by a diesel engine. In mid-June 1939, pressure was put upon Junkers to transfer its interest in gas turbines to the engine company; this was done, but Mueller and most of his staff went to Heinkel and, as related above, continued development of the axial turbojet there.

In the summer of 1939 Junkers received an official contract for a new axial turbojet, the 109–004, developed under Dr. Anselm Franz. This engine included no novel or uncertain features; it was designed to be brought into production and operation with all possible speed, even at some sacrifice in performance. The requirement was for 1,320 lb. thrust at 560 m.p.h., or about 1,500 lb. static. It was developed from the outset to burn diesel oil.

Following construction of a small scale model in 1939, work proceeded on the 004A, which first ran in November 1940. Various problems were encountered, and the first flight was not made until March 15, 1942, beneath an Me 110; the engine was then giving about 1,850 lb. s.t. This was followed by the flight of two 004As in an Me 262 on July 18, 1942, this being also the first flight of the Me 262 on jet power alone.

About 30 004As were built, while development of the first true production model, the 004B–0, proceeded. This was running in January 1943, and gave 1,850 lb. thrust for a weight 200 lb. less than that of the 004A. It was followed by the 004B–1, which gave 1,980 lb. in June 1943, and was first flown in an Me 262 in October. This model went into production, with deliveries beginning in March 1944, and was later superseded by the 004B–4. A further model, the D–4, ready for production when the war ended, would have given 2,310 lb., and the projected 004H, with an eleven-stage axial compressor and two-stage turbine, was rated at 3,960 lb. s.t.

In all, about 5,000 109–004s were built, to power the Me 262s (1,249 built) and Arado Ar 234Bs (214 built).

Junkers had been earmarked in 1942 for development of a new turbojet, the 109–012 (and a corresponding turboprop, the 109–022) as soon as the 004 was in production. In fact, only one 012 was ever built and this was not tested before the war ended.

B.M.W. (and BRAMO)

When the German Government began to take an interest in turbojets in 1938 Bramo and B.M.W. were among the companies invited to tender designs. Bramo initially did some work on a ducted-fan powered by a piston engine, but by the end of the year a two-fold development programme had been decided upon: a counter-rotating axial flow engine and an axial turbojet. All development of these engines was subsequently continued by B.M.W., which absorbed the Bramo works at Spandau in mid-1939.

The counter-rotating engine became the 109–002; it was abandoned in 1942 without being run, and the ducted-fan was discontinued at the end of 1941.

B.M.W. studies, at the original Munich works, concentrated in 1938 on a centrifugal type of engine, but it appeared that the original Bramo axial turbojet was more promising, and the B.M.W. Munich project was discontinued in September 1939 in favour of the Spandau engine, which was known as the P3302 and later became the 109–003.

Construction of a batch of 003s began in 1939, and the first was run in 1940, when the thrust was only 570 lb. compared with the design figure of 1,500 lb. Two of these engines were fitted in an Me 262 and flown in 1941, but because of their inadequate power, a Jumo 211 piston engine had to be used also to enable the aircraft to leave the ground. Flight trials on an Me 110 began later that summer.

Extensive redesigning was undertaken, and the new engine, 003A–0, with a greater mass flow ran at the end of 1942, by which time the original model was giving 1,210 lb. s.t. The 003A–0 flew beneath a Ju 88 in October 1943, and pilot production was ordered. This was followed by the production A–1, of which 100 had been delivered by August 1944. With the later 003A–2, they were used to power the Heinkel He 162 and Arado Ar 234C, and in September 1944 an Ar 234 with these engines reached 42,000 ft.

In 1944 work began on the 2,420 lb. s.t. 003D, a new engine with the original dimensions of the 003, using an eight-stage compressor and two-stage turbine, intended for the Ar 234. This engine was never built.

B.M.W. also did some work to develop the 003R, which incorporated a 2,750 lb. thrust rocket engine for boosting.

As early as 1940 B.M.W. projected a large turboprop, and in 1941 this was designated the 109–028 for future development, with the 018 as a corresponding turbojet. The 028 was planned to give 7,900 e.h.p. at 500 m.p.h. at 23,600 ft. for a Focke-Wulf two-motor bomber project, while the 7,500 lb. s.t. 018 was earmarked for the Ju 287. One complete 018, with a twelve-stage compressor and three-stage turbine, was finished in December 1944 but was never tested.

DAIMLER-BENZ

This company was not impressed with the possibilities of jet propulsion when first approached by the government, but was eventually persuaded to start work, under contract, on a turbine-driven ducted-fan. This was designated the 109–007 and used a counter-rotating turbine, but Daimler-Benz made no real attempt to bring the engine to a developed state and the project petered out in 1943. It was designed to give 3,080 lb. at 560 m.p.h., but when dropped was giving only 1,340 lb. and had not flown.

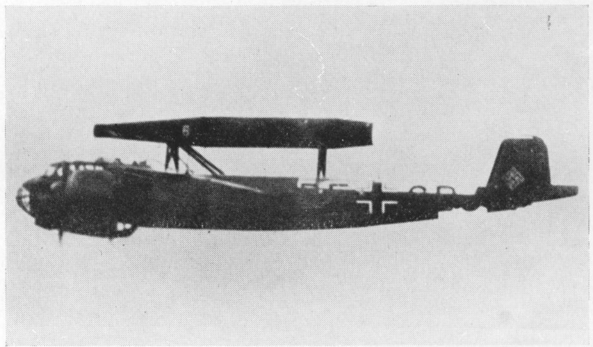
In its place Daimler-Benz proceeded with the 109–021 turboprop version of the Heinkel 011, which was required for a long-range reconnaissance version of the Arado Ar 234. No prototype was complete by the end of the war.

PULSE JETS AND RAMJETS

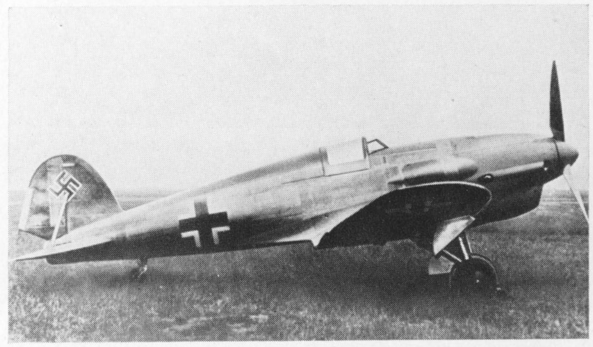
In 1931 Paul Schmidt, an independent inventor, gained a government contract for development of a pulse-jet unit, based on the Karavodine gas generator. This work was officially supported from then until the end of the war, but Schmidt refused, in 1939, a government plan to transfer development of his engine to the Argus Motoren works.

Consequently Argus embarked upon their own design for a pulse jet, which was wanted for the Fi 103 (V–1) flying bomb. This unit, the 109–014, which developed 740 lb. thrust, made its first flight beneath a Gotha Go 145 on April 28, 1941. Apart from its large-scale use on the Fi 103, the 014 was unsuccessfully fitted to the experimental Me 328B fighter.

A little progress was made with small ramjets, by the D.F.S. at Ainring (under Dr. Eugen Saenger) and by Focke-Wulf at Bad Eilsen (under Dr. Otto Pabst). Both these units were test flown, mounted on the back of a Do 217E and a Do 17Z respectively, but no practical applications were made. The Saenger unit developed 2,400 h.p., and a 20,000 h.p. unit had been planned.

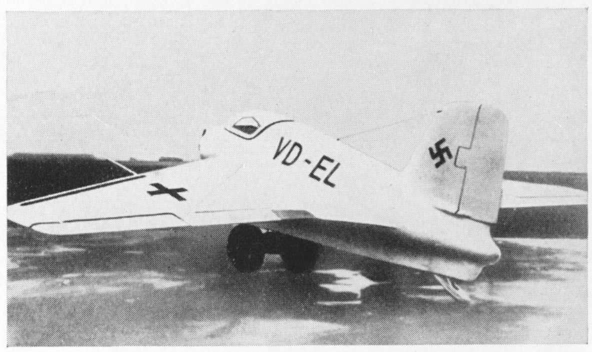


(Above) *A Dornier Do 217E–2 with a Saenger ramjet unit.*

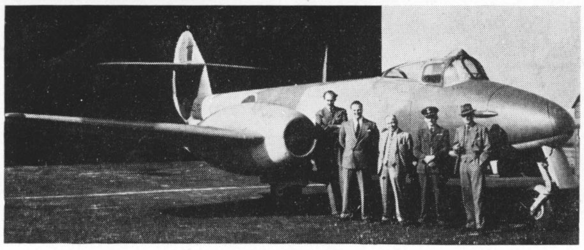


(Above) *An He 112 with liquid-fuel rocket in rear fuselage.*

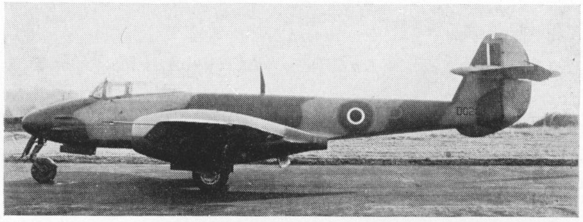
(Above) *Me 262V–5 with Walter assisted-take-off rockets.*



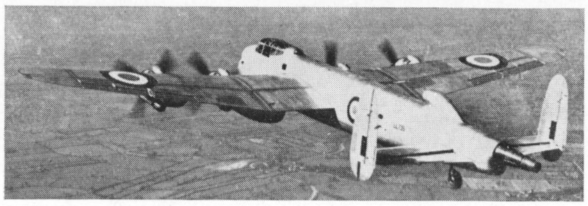
(Above) *Me 163A, originally tested with HWK R.II rocket and* (below) *the Me 163V–6 with a Walter 109–509C rocket motor.*

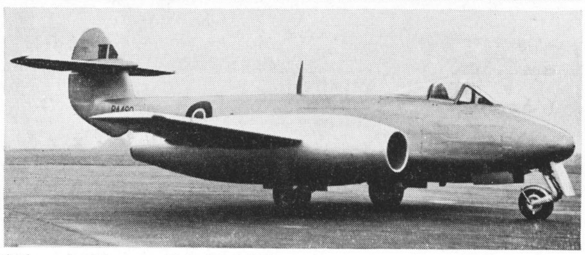


(Above) *Gloster F.9/40 (DG205/G) with Rover W.2Bs.* (Below) *F.9/40 (DG208/G) with Rolls-Royce W.2B/23s.*



(Above) *F.9/40 (DG204/G) with Metrovick F.2s and* (below) *a Lancaster B.2 (LL735) with a similar unit in rear fuselage.*





(Above) *Meteor F.4 (RA490) with Metrovick Berlys.* (Below) *Lancaster B.6 (ND784/G) with A.S.X. turbojet in bomb-bay.*

ROCKET UNITS

A good deal of work was done on rocket engines in Germany, quite apart from that connected with the A.4 (V–2) and other missiles. As early as 1935, a Government department was working on development of a 650 lb. liquid fuel rocket; this was successfully run on a test stand at Kummersdorf and was later fitted beneath the fuselage of a Junkers Junior for trials on a centrifuge, to measure performance under flight conditions.

This engine was fitted in the rear fuselage of a Heinkel He 112 for its first flights, made by Flugkapitan Warsitz in the spring of 1937. This series of trials ended in a forced landing.

The work continued at Peenemünde and a new assisted-take-off unit giving 2,200 lb. thrust for 30 seconds was developed by Dellmaier. These units used *A–stoff* (liquid oxygen) as the oxident, and consequently were not adopted for service, although a series of test flights were made at Peenemünde in 1939–40 using two units on a Heinkel He 111. The Walter rocket using *T-stoff* (hydrogen peroxide) was eventually adopted for assisted-take-off use.

The next stage was a fighter rocket unit, intended to have a burning time of five minutes and a controllable thrust, giving a climb to 40,000 feet in two minutes. The Walter design to meet this requirement was more quickly and simply produced than the Peenemünde rocket motor, and was fitted to the Heinkel He 176 which flew at Peenemünde West in June 1939. The Peenemünde rocket motor was fitted in a further Heinkel He 112 in which it had a burning time of two minutes. This He 112 made several flights before it was destroyed.

Helmut Walter had begun development of rocket engines in 1937, and the first unit designed as a primary aircraft power plant was the HWK.R.I which, as previously mentioned, was installed in the He 176 early in 1939, giving 1,100 lb. thrust. The R.I used *T-stoff* (hydrogen peroxide) and potassium or calcium permanganate as a catalyst. The pilot production model, the HWK.R.II, was tested in the Me 163V–1 and V–2, but its dangerous characteristics led to the unit's complete redesign and the use of a new catalyst known as *C-stoff* (hydrazine hydrate and methyl alcohol). Running at higher temperatures than its predecessors, this motor entered production as the 109–509A for the Me 163B fighter, having a thrust range of 440–3,750 lb. A further development, the 109–509C, had an auxiliary cruising chamber and a maximum thrust of 4,400 lb. This was tested in the Me 163V–6, prototype for the Me 163C series, in 1944. Other production units were the 109–500, –501, and –502 assisted-take-off motors giving 1,200, 2,200 and 3,200 lb. thrust respectively.

The B.M.W. concern also evinced interest in rocket development, producing the B.M.W.718 bi-fuel unit which provided a thrust of 2,700 lb. for three minutes. Coupled with a B.M.W.003A turbojet, the B.M.W.718 was used in the experimental Me 262B–1 (*Interzepter I*), a coupled unit, designated B.M.W.003R, being installed in each nacelle.

GREAT BRITAIN

The two lines of development which give rise to all present British gas-turbine work were initiated by Dr. A. A. Griffith at the R.A.E. in 1926, and by Sir Frank Whittle, as a Flight Cadet at Cranwell in 1928.

Dr. Griffith produced in 1926 an aerodynamic theory of turbine design based on flows past aerofoils instead of through the passages between blades. Some preliminary research work on compressor and turbine blading began in 1927 and results were encouraging, but progress was slow. In 1929 Dr. Griffith proposed an internal-combustion turboprop engine, using an axial compressor, and some preliminary investigations were undertaken, but no complete axial compressor was built at the Royal Aircraft Establishment until 1936. Thereafter, work progressed more rapidly and in 1937 Metropolitan Vickers were invited to co-operate. This company built a number of experimental engines based on R.A.E. designs; the first of these was the B.10 (Betty) turbo-compressor, run on the bench in October 1940. This was followed by the D.11 (Doris), with a seventeen-stage axial compressor and eight-stage turbine, together with a five-stage low-pressure turbine taking gas from the high-pressure turbine.

Meanwhile, Fl.-Lt. Frank Whittle was busy developing his own jet-propulsion engine. This arose from his inspired combination of the gas turbine and pure-jet propulsion—Dr. Griffith proposed to use his compressor to drive an airscrew, and earlier fanciful ideas for pure-jet propulsion had not foreseen the use of the gas turbine in its present state. Whittle had a long and, at times, bitter struggle to gain recognition for his work, which can be considered to have begun with his first patent, dated January 1930.

Whittle did gain a small measure of private support, however, and by April 12, 1937, he was able to run his first engine, known as the "U", which had been built for him primarily by British-Thomson-Houston.

Air Ministry interest and recognition followed, and the "U" was twice rebuilt between then and February 22, 1941, when the turbine disc failed. By this time Power Jets Ltd., the company formed to develop Whittle's engines, had gained sufficient financial backing for the work to continue.

Just before the "U" failed, a new engine, the W.1X (also built by B.T.H.), commenced running, and this engine was fitted in the first Gloster E.28/39, the first British aeroplane designed for jet propulsion. With this engine it taxied and made a short straight hop, although the W.1X was not intended as a flight engine. The E.28/39 made its first true flight on May 14, 1941, for which a new engine, the W.1, was fitted.

This milestone passed, Power Jets became, at the instigation of the government, primarily a research and development organisation; in any case, it possessed no facilities for large-scale production. Direct contracts were placed with B.T.H., Vauxhall and Rover for the production of Whittle-type engines, but the B.T.H. and Vauxhall factories were subsequently required for other work and all initial production devolved upon the Rover company. Power Jets meanwhile began work on the W.2, a larger and improved development of the W.1; it was not in itself successful but led to the improved W.2B design.

Rover then incorporated several of their own ideas in the W.2B/23, two of which were installed in the first Gloster F.9/40 in July 1942 but did not give enough power for flight. In November 1942, a Rover W.2B/23 passed a 25-hr. special-category test at 1,250 lb. thrust, and began flight trials in the rear of a Wellington. In January 1943 it passed a similar test at 1,400 lb. and made its first "solo" flight in an E.28/39 in March. Later in the same month the design power of 1,600 lb. was reached.

Power Jets, meanwhile, developed a W.2B Mk.2, which ran in December 1941, and gave 1,510 lb. thrust, but was short-lived because of turbine failure. It was followed by the W.2/500, which gave 1,755 lb. on its first run in September 1942.

Rover were unable to continue with their work on gas turbines after the end of 1942, and Rolls-Royce were asked to take over. The latter company had already built for the Ministry of Aircraft Production the WR.1, an engine based on the W.2B but incorporating several Rolls-Royce ideas. Two were built during 1942, but not flown, and the project was suspended in March 1943.

From Rover, Rolls-Royce took over production of the W.2B/23, which was named the Welland—the first of the River-class engines—and the development of the W.2B/26, which became the prototype of the Derwent. In April 1943 a Welland passed a 100-hr. type test at 1,600 lb. and on June 12 an F.9/40 flew with these engines for the first time.

The W.2B/26 was a Rover prototype using "straight-through" flow, whereas all the earlier Whittle types were of the reverse flow type in which the air, after compression, was led to the far end of the combustion chamber, to flow from rear to front during combustion and then change direction again back through the turbine blading. All Whittle's engines also used a centrifugal compressor. In 1940 Whittle himself designed two straight-through engines, the W.2X and W.3X, but did not favour this lay-out.

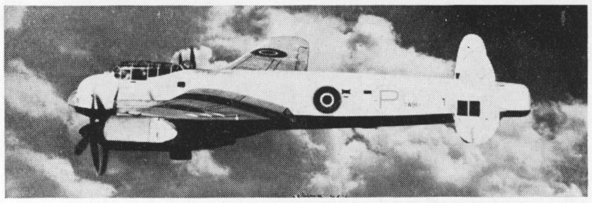
The Rover W.2B/26 first ran in November 1942, and it was upon this engine that Rolls-Royce concentrated development throughout 1943, while producing the small production batch of Wellands. Use of a new impeller, new diffuser and scaled-up turbine, gave rise to the W.2B/37, which went into production as the Derwent.

Meanwhile, Power Jets built the W.2/700, tested in July 1943, in which longer turbine blades gave increased mass air flow and, therefore, increased thrust. This was the last Power Jets engine built but one other design deserves mention. This was a small turboprop designed to give 250 e.h.p. Development was taken over by Coventry Climax who built and ran the engine as the C.P.35 before work was discontinued. In April 1944 the company was nationalized to become a publicly-owned corporation, Power Jets (Research and Development) Ltd. Thereafter, it did no engine construction. The aircraft gas turbine had established itself in Britain and most of the recognised aero-engine manufacturers were interesting themselves in its development. The work of these companies is now described.

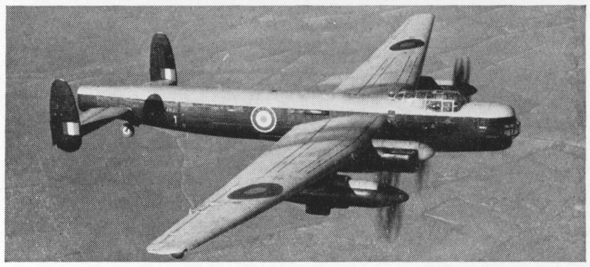
METROPOLITAN-VICKERS

This company's earlier work in association with Dr. Griffith and the R.A.E. has already been outlined. In July 1940 Metrovick began construction of an axial turbojet designed for flight trials. This originated at the R.A.E. as the F.1, a 2,150 lb. s.t. unit which was designed in December 1939, and was to be built by Power Jets. Metrovick took over the design as the F.1A of 2,690 lb. s.t., and the design was further modified into the F.2, using the R.A.E. "Freda" nine-stage axial compressor, annular combustion chamber and two-stage turbine.

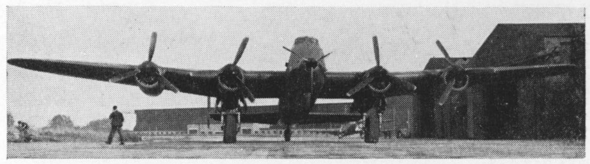
The F.2 was first run in December 1941, giving 2,200 lb. s.t. After rebuilding with modifications, as F.2 (the third built) was flown for the first time on June 29, 1943, in the tail of a Lancaster from Baginton. On November 13, 1943, the first two F.2s powered a Gloster F.9/40 on its



(Above) *Lancaster B.1 (TW911) with Pythons outboard.*

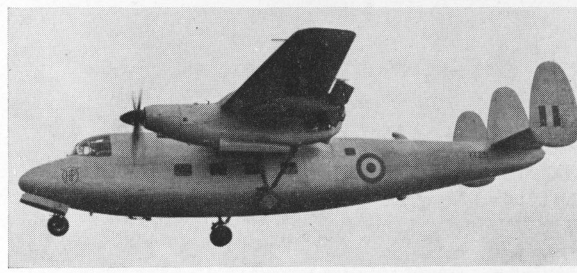


(Above) *Lincoln (RF403) with Python turboprops outboard.*

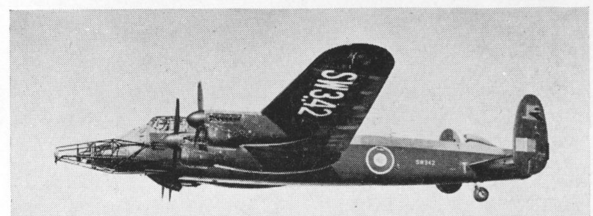


(Above) *Lancaster B.6 (ND784/G) with Mamba in the nose.*

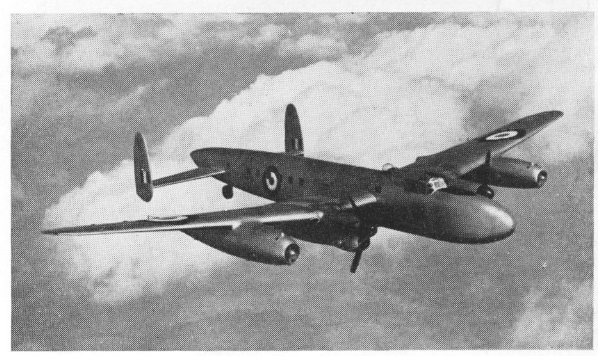
(Above) *Dakota (KJ839) with Mamba turboprops.*

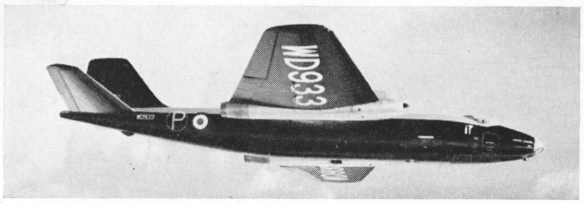


(Above) *Marathon 2 (VX231) with Mamba turboprops.*

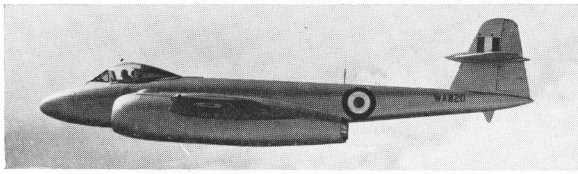


(Above) *Lancaster (SW342) with Mamba in nose and Adder in tail.* (Below) *Lancastrian (VM733) with Sapphires outboard.*

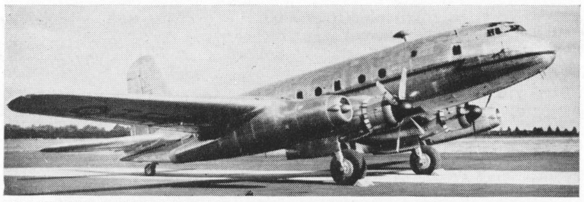


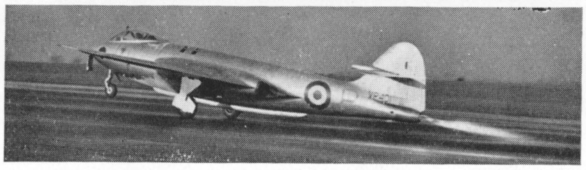


(Above) *Canberra B.2 (WD933) with Sapphires.*

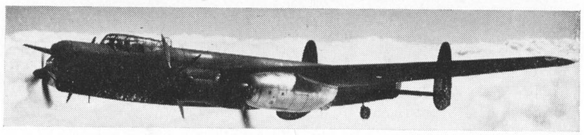


(Above) *Meteor F.8 (WA820) with Sapphires and* (below) *Hastings (TE583) with Sapphires outboard.*



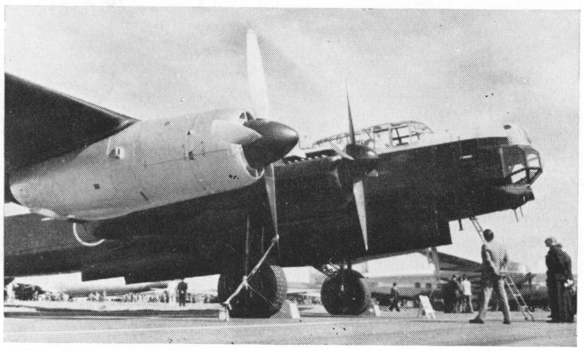


(Above) *Hawker P.1072 (VP401) with Snarler in tail.*

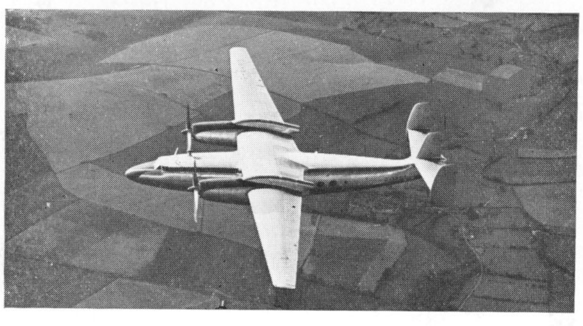


(Above) *Lincoln (RA716/G) with Theseus units outboard.*

(Above) *Hermes 5 (G–ALEU) with Theseus turboprops.*



(Above) *Lincoln (SX972) with Proteus turboprops outboard and* (below) *the similarly-powered Ambassador (G–AKRD).*



first flight—the first flight in Britain of an aircraft powered solely by axial turbojet engines. The F.2 as flown was rated at 1,800 lb. s.t.

After production of three batches of the F.2, principally for experimental purposes, the engine was redesigned and a fourth batch built under the designation F.2/4. This engine was named the Beryl—first of the "precious stones" class—and used to power an experimental Meteor and the three Saro S.R.A.1 flying boats. The F.2/4 had a ten-stage compressor and single-stage turbine. It was first run in January 1945; designed for 3,500 lb. s.t., it eventually gave 4,000 lb.

The company also designed the first British ducted-fan augmenter, the F.3, which was based on the F.2 and began bench running in August 1943. It developed 2,400 lb. s.t. without the augmenter and 4,600 lb. with it. Neither the F.3, nor a further development, the F.5, with a two-stage open fan, ever flew.

Finally came the F.9 Sapphire, a larger axial-compressor engine than the F.2. When Metrovick decided to terminate their work on aircraft gas turbines early in 1948, work on this was taken over by Armstrong Siddeley, but the first F.9 was run by Metrovick on May 7, 1948, before the transfer.

ARMSTRONG SIDDELEY

This company did some work under sub-contract in connection with the Griffith/R.A.E. experiments, but did not begin serious study of the gas turbine until November 1942, when they received a contract for a large axial-flow engine. This appeared as the A.S.X., with the R.A.E. "Sarah" fourteen-stage axial compressor and a two-stage turbine. It first ran in March 1943, and after steady development made its first flight in June 1945 in a Lancaster test-bed. The fifth and seventh engines were flown and amassed forty-eight hours in the air up to June 1946, when the tests were completed.

From the A.S.X. was developed the A.S.P., a turboprop version first run in March 1945. This in turn led to the Python, the first of the "Reptile" class engines. The Python, type tested at 3,560 e.h.p., was first flown in a Lancaster (January 3, 1949), and powers the Wyvern, in which it first flew on March 22, 1949.

In 1945 work began on a small turboprop in the 1,000 h.p. class. This ran in April 1946 and was named the Mamba; it used a ten-stage axial compressor and two-stage turbine. A power of 1,013 s.h.p. was achieved on the bench in December 1946. Test flying began in the nose of the Lancaster test-bed on October 14, 1947, and was continued in a second Lancaster and a Dakota. An interesting development of the basic design is the Double Mamba, comprising two standard units side by side driving two co-axial, counter-rotating and completely independent airscrews. It is thus possible for one "half" of the engine, with its appropriate propeller, to be stopped, while the other continues to operate. The Double Mamba made its first flight in a Fairey Gannet on September 19, 1949, and also powered the Blackburn Y.B.1 (flown on July 19, 1950).

From the Mamba came the Adder, a turbojet adaptation intended primarily for short-life applications in target aircraft. It was run on November 8, 1948, and first flew in the Pika two years later on November 1, 1950. It has also been flown in a Lancaster test-bed, the Jindivik 1 and the Saab Draken. Armstrong Siddeley re-heat experiments began on an Adder on January 1, 1950.

The Viper is another small turbojet, giving more power than the Adder and having an annular combustion chamber and an eleven-stage compressor. It was designed originally to be a short-life engine, and first ran in April 1951. Flight trials in a Lancaster began in November 1952, and the short-life version powers the Jindivik 2. Long-life versions of the Viper have now been developed and have some interesting applications which include the Folland Midge and Percival Jet Provost. One version of the long-life Viper, the A.S.V.7R, has now been developed with re-heat, and trials at very high altitude are being made with a Viper mounted at the wing-tip of a Canberra; both these lines of development are required for future Viper applications.

The Sapphire, as already mentioned, was a Metrovick design, taken over by Armstrong Siddeley in 1948, and first run by them on October 1, 1948. It is now the subject of most of Armstrong Siddeley development. The Sapphire is an axial-flow engine with an annular combustion chamber, full details of which have not been revealed.

Flight trials began in a Lancastrian on January 19, 1950, with two Sapphire A.S.Sa.1s; these were type-tested at 7,220 lb. s.t. in the summer of that year. The A.S.Sa.2 first flew in a Meteor 8 on August 14, 1950, and was also flown in a Hastings. The first production Sapphire, the A.S.Sa.3, passed its type test at 7,500 lb. in November 1951, and a development of this engine, the A.S.Sa.6, was type tested at 8,300 lb. in April 1952.

The A.S.Sa.6 was first flown in one of two Canberras used for Sapphire development; they have now been replaced by 10,200 lb. s.t. A.S.Sa.7s first flown on August 13, 1954. Re-heat trials with the Sapphire began on the test-bed on September 21, 1950, and were continued in the air in the second Canberra in 1954.

In 1946 Armstrong Siddeley received a contract for the development of a rocket engine to give 2,000 lb. thrust and to be suitable for use as an assisted climb unit. This unit materialised as the Snarler, using a mixture of methyl alcohol and water as the fuel and liquid oxygen as the oxidant. The Snarler first ran on test on November 11, 1947, and, with a fully automatic control system for the fuel pumps, in February 1950.

The Snarler was fitted in the tail of the Hawker P.1072 for test flying, and made its first flight on November 20, 1950. The Snarler increased the rate of climb of this aircraft at 30,000 ft. five times. Development of the Snarler ended in 1952, the company moving onto a more advanced take-off and climb rocket, with which the name Screamer has been associated. It may be that this engine makes use of the liquid oxygen and kerosene propellent combination initially used in the Snarler. This would give a very high value of specific impulse.

BLACKBURN

Blackburn and General Aircraft Ltd. hold exclusive manufacturing and selling rights in the U.K. and Commonwealth for the Turboméca range of gas-turbines. The Palas turbojet, the Palouste air compressor and the Artouste and Turmo shaft turbines are being worked upon initially. Blackburns are developing these engines in two series, the 600 type, and the 500 type in which the design is modified to have about two-thirds of the air mass flow, and correspondingly reduced performance.

BRISTOL

When this company began work in the gas-turbine field, during the war, it decided to aim primarily at producing power plants for large, long-range aircraft. Consequently, the first Bristol jet engines were turboprops of fairly high power. Type names from Greek mythology were used, as for Bristol piston engines.

The Theseus, a turboprop of a little over 2,200 h.p. (plus 800 lb. residual jet thrust) first ran on the bench in July 1945, and it became the first turboprop to pass the 100-hr. M.o.S. type test and to complete a 150-hr. A.R.B. type test. The Theseus was an axial engine, with eight stages, plus a ninth centrifugal stage, and a three-stage turbine, of which two stages drove the compressor and the third "free" turbine stage (with no mechanical coupling to the first two) drove the propeller through concentric shafts. The Theseus first flew in a Lincoln, and two other aircraft of this type were subsequently modified for trials along Transport Command routes. Two experimental Handley Page Hermes 5s were also Theseus powered.

In February 1947 the first Proteus ran. This engine made use of Theseus experience, and used a twelve-stage axial compressor, plus one centrifugal stage, with a three-stage turbine as on the Theseus. Later versions of the Proteus have a four-stage turbine, however, with two stages each for compressor and propeller. First flights of the Proteus were made in a Lincoln and are being continued on a development basis in an Ambassador. The engine is also used in the Princess prototype and the Britannia. For the Princess and the projected Brabazon 2, the Coupled Proteus was developed, comprising two Proteus units linked to a common airscrew shaft. This first ran in November 1949 and flew only in the Princess.

Bristol pure-jet experience began with the Phoebus, a 2,540 lb. s.t. engine based on the Proteus and intended only for development flying —undertaken in a Lincoln. The first major Bristol turbojet is the Olympus, a twin-spool axial engine, first run on June 13, 1950. First flights were made in a Canberra, and the Olympus powers the production Vulcans. Tests with the Olympus fitted with Bristol simplified re-heat system will be made on an Ashton.

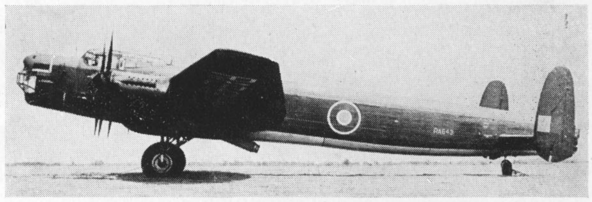
Several turbojets of lower power have been designed by Bristol, the first of these being the Janus. This was designed to give 525 lb. s.t., using a small axial compressor, but did not get beyond bench running. Designed to give 3,800 lb. s.t. and selected by Folland to power the Gnat light fighter, the Saturn did not get beyond the design stage, but has been succeeded by the B.E.26 Orpheus, a lightweight axial engine designed to give 4,850 lb. s.t., or up to 6,000 lb. s.t. with the Bristol re-heat system.

In September 1954 details were announced of the Bristol B.E.25, a supercharged, twin-spool, turboprop designed to give a constant 4,000 e.h.p. from sea level up to about 25,000 ft. This engine is destined to power developed versions of the Britannia and Super Britannia, the existing Princess flying-boats, and other types.

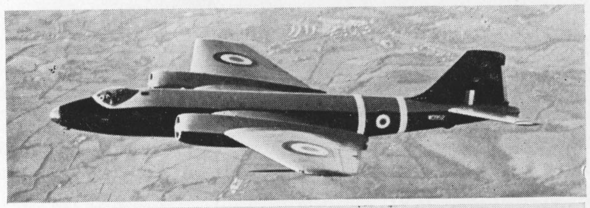
Other Bristol activities at present include development of the B.E.32, a 1,000 h.p. free turbine turboprop which might be suitable for DC–3 replacement aircraft and will be used in future Bristol twin-rotor twenty-seven-seat helicopter. The company is also developing ram jets for use on guided missiles.

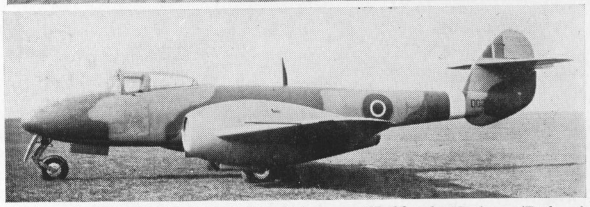
DE HAVILLAND

This company entered the gas-turbine field in January 1941, when they began design of a new turbojet engine, and a new fighter to make use of it. The first engine was designated the H.1 (after its designer, Major

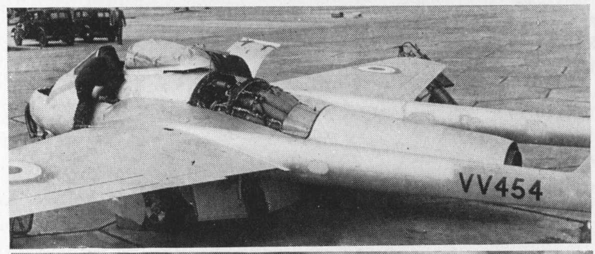


(Above) *Lincoln* (*RA643*) *with Phoebus in bomb-bay.* (Below) *Canberra B.2* (*WD*)*52*) *with Olympus turbojets*





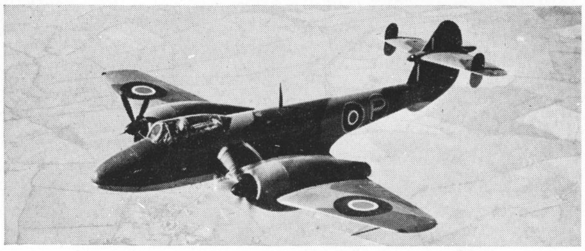
(Above) *F.9/40* (*DG206/G*) *with two Halford H–1s.* (Below) *Vampire* (*VV454*) *with afterburning Goblin.*



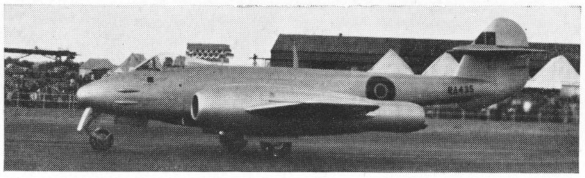
(Above) *Lancastrian* (*VM703*) *with Ghosts outboard and* (below) *Vampire* (*TG278*) *with Ghost turbojet.*

(Above) *Lincoln* (*RE530*) *with Naiad in nose.* (Below) *Varsity* (*VX835*) *with Elands.*

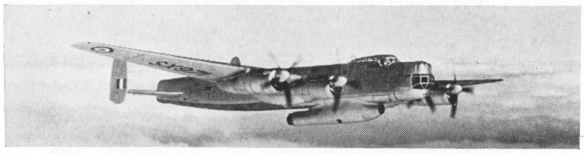
B

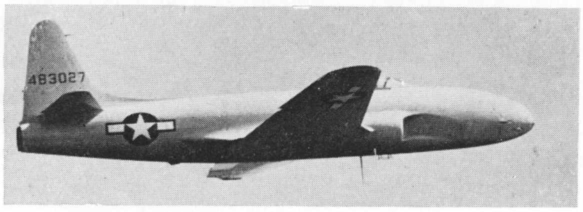


(Above) *Meteor F.1 (EE227) with Trent turboprops.*

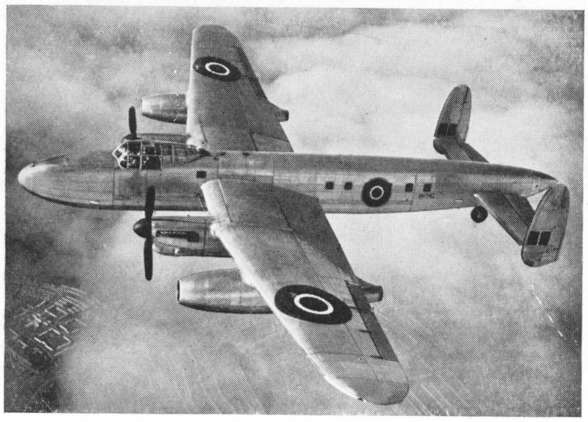


(Above) *Meteor F.4 (RA435) with afterburning Derwents and* (below) *afterburning Derwent under Lincoln (SX971).*

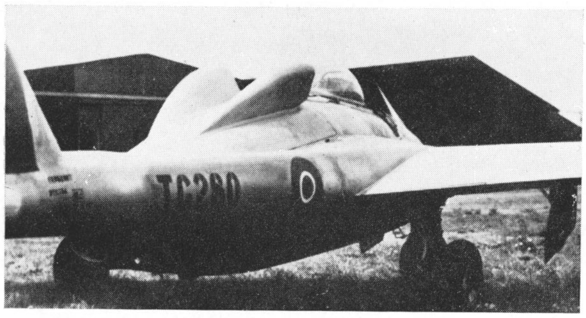




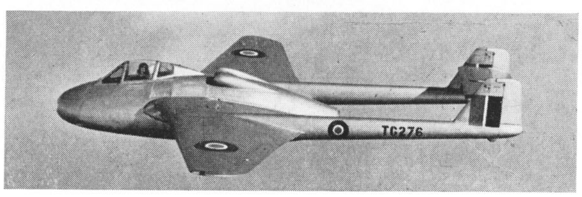
(Above) *Lockheed Shooting Star (44–83027) with Nene.*



(Above) *Lancastrian (VH742) with Nenes outboard.*



(Above) *Vampire F.2 (TG280) and* (below) *(TG276) with Nenes.*



Halford) and was later named Goblin. From the outset, its development went hand-in-hand with work on the airframe, which became the Vampire.

The H.1 first ran in April 1942 and the first flight was made on March 5, 1943, in a Gloster F.9/40 prototype, this being also the first flight of an F.9/40. It was type tested at 2,700 lb. in January 1945 and as the Goblin 2 reached 3,000 lb., the original design rating, in July 1945.

The Goblin, unlike the Whittle engines, used a single-sided centrifugal compressor and a straight-through combustion system. As a larger development of the design, the company produced the H.2 Ghost, rated initially at 4,000 lb. s.t. but similar to the Goblin in all general respects. First flown in a Lancastrian test-bed, the Ghost has been developed in two principal versions, as the Ghost 50 of 5,050 lb. thrust, with a single intake for the Comet; and as the Ghost 103 and 104 of 4,850 lb. thrust, with bifurcated intakes for the Venom series. Some work was also done by de Havilland on the H.5, a developed Ghost engine to give 6,000 lb. s.t.

The only announced de Havilland turboprop design was the H.3, a 500 e.h.p. centrifugal compressor engine which was bench run but subsequently abandoned. Some work was also done on the H.7 gas producer for helicopter applications.

Latest announced de Havilland turbojet is also the most powerful engine run in this country to date, and is expected to reach 20,000 lb. without re-heat when developed. This is the H.4 Gyron, the first de Havilland axial engine. It will fly soon in a Short S.A.4, and is likely to be used, with re-heat and in combination with take-off and climb rocket engines, for very advanced fighters designed to reach speeds of Mach 2 or more, at altitudes in excess of 60,000 ft.

The de Havilland company embarked upon rocket engine development in 1946 and obtained an M.o.S. contract for this work in the following year. The first such engine developed was the Sprite, which had a maximum performance of 5,000 lb. thrust spread over 16 seconds. It was a liquid-propellant rocket, using 85 per cent high-test hydrogen peroxide as a monopropellant, and it was developed primarily as an assisted-take-off engine. It first flew in the Comet in April 1951.

In the summer of 1952 a new M.o.S. contract was obtained to cover development of the Super Sprite as a fixed assisted-take-off unit, and also as a jettisonable unit. For this particular type of operation, on medium jet bombers, the Super Sprite is now in production, together with its jettisonable pack containing parachutes. It has a maximum thrust of 4,200 lb. for 40 seconds, and as it uses kerosene as a fuel is a "hot" rocket.

A new D.H. rocket engine, intended for take-off and climb applications, has been reported, and the name Spectre has been associated with this development.

FEDDEN

Named the Cotswold, this engine was under development by Sir Roy Fedden after the end of the war, against an M.o.S. contract. When this contract was terminated during 1947, however, the work was abandoned. The Cotswold was a turboprop designed to give 1,425 e.h.p. with an eleven-stage axial compressor and a two-stage turbine.

NAPIER

Work on gas-turbines was begun by this company soon after the end of the war, and details of the first Napier engine, the Naiad turboprop, were announced in October 1947. The Naiad was a 1,600-e.h.p. engine using a twelve-stage axial compressor with a two-stage turbine. It flew in two Lincolns, but plans for its installation in a Wellington were abandoned and it was not further developed.

Another of the series of low-powered turboprop engines designed but discontinued when M.o.S. support was withdrawn was the Nymph, designed to give 535 e.h.p.

Initially flight-tested in a Varsity, the Eland is the first of a new line of Napier engines based on a long period of compressor development. Design work began late in 1950, with a target power of 3,000 e.h.p. The Eland E.141 first ran on August 19, 1952 and began its flight trial in the summer of 1954. It has a nine-stage axial compressor and two-stage turbine, and has been adopted for use in the Rotodyne convertiplane, which will have the E.151 version. A later Eland variant, the E.153, has now been developed and gives about 4,000 e.h.p.

Latest Napier gas-turbine is the Oryx, the first-announced version of which is a gas producer for the Percival P.74 ten-seat helicopter. The Oryx is of very small diameter, and has an axial flow compressor. The turbine, which drives the main compressor, also powers an auxiliary compressor. The exhaust gases from the turbine and the air from the auxiliary compressor are mixed before being ducted along the rotor to produce propulsive jets at the blade tips.

ROLLS-ROYCE

This company's early work on the WR.1 and subsequent assumption of production responsibility for the W.2B series from Rover has been noted. Its interest in gas-turbines goes back at least to 1938, however,

and in that year Dr. A. A. Griffith joined the company from the R.A.E. At Rolls-Royce he continued development of his counter-rotating, contraflow engine, then envisaged as a ducted fan although suitable for use as a turbojet or turboprop.

This engine ran on compressed air in October 1941, and under its own power in 1943, but it never flew and was finally abandoned in October 1944. One of its important uses was in the development of rotary burners and fuel injection in annular combustion chambers.

The Derwent, which was the Rolls-Royce version of the Rover-built W.2B/26, was tested in July 1943, passed a 100-hr. type-test at 2,000 lb. in November and made its first flight in a Wellington in December. This type of engine powered the Meteor 3.

In January 1944 work began on a new Derwent, the Mk. 2, using a new blower casing developed by Power Jets for the W.2/700; less than a dozen of this version were built, the first being run on June 29, 1944. The Derwent 3 was a special engine used for boundary layer control experiments in a Meteor, and the Derwent 4, with further improvements to give 2,350 lb. thrust, began running in February 1945.

On March 17, 1944 design work began on a new engine, designated RB40, to give 4,200 lb. to meet the needs of an M.o.S. requirement. This engine was subsequently linked with a new Supermarine jet fighter, the E.10/44, for which a power of only 3,300 lb. was then required. A scaled-down version was designed to give this thrust and became the RB41, later named the Nene. Before this engine ran in October 1944, however, it had been re-rated at 4,500 lb. s.t., which was quickly achieved. It was first flown in the Lockheed P–80 in July 1945, and tests were continued in two Lancastrians. The scaled-down version was built as the Derwent 5, first run in June, flown in a Meteor 3 on August 5, 1945, and rated in September 1945 at 3,500 lb. Later Derwents, the Mks. 8 and 9, are rated at 3,600 lb. s.t.

A development of the Nene undertaken jointly by Rolls-Royce and Pratt and Whitney appeared as the 6,250 lb. s.t. Tay. It has flown in this country only in a Viscount. All the Rolls-Royce turbojets up to this point were based directly on the Whittle line, although all were straight-through rather than reverse-flow engines.

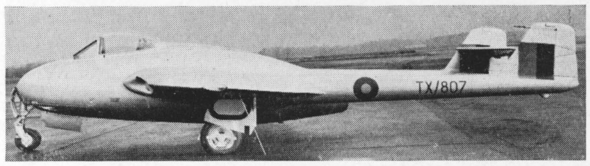
Turboprop development by Rolls-Royce began in 1943, and a turboprop version of the Derwent, named the RB50 Trent, was flown in a Meteor in September 1945; this was the world's first turboprop flight. This engine, which gave 1,230 e.h.p., was not further developed, but work continued on a much larger unit, the RB39 Clyde. This had started at the end of 1943 as a 3,000 e.h.p. engine, having a nine-stage axial compressor plus one centrifugal stage; it was the first Rolls-Royce axial engine, and was a compound type with a free turbine. Bench tests began in December 1944. Eleven Clydes were built, and eventually developed powers much in excess of the design figure; 25-hr. flight clearance tests were completed at 4,030 e.h.p. and, with water methanol injection, 4,500 e.h.p. The Clyde flew in a Wyvern on January 18, 1949 and accumulated 50 hours in flight before work was discontinued.

A smaller turboprop, the Dart, had begun its flight trials in the nose of a Lancaster in October 1947 and completed its type-test in 1949. Flight development continued in Dakotas and a Wellington, leading to its adoption for the Viscount, forming a highly successful combination. It is a centrifugal engine, with two stages and a two-stage turbine. Current versions are the Dart 506 giving 1,540 e.h.p. and the Dart 510 rated at 1,690 e.h.p.

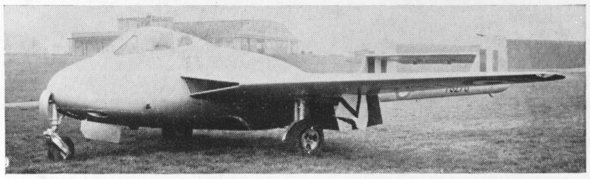
The first Rolls-Royce axial turbojet design was the AJ25 (from axial jet 2,500 lb. s.t.) and was tentatively named the Tweed. It remained a paper design while being developed for greater thrust, and the series eventually led via the AJ50 and AJ60 to the AJ65, which was the first version of the Avon. The Avon R.A.2 was type-tested at 6,000 lb. s.t. in mid-1947, and the first production engine, the R.A.3 Avon 1 (and Avon 100), was type-tested at 6,500 lb. s.t. late in 1950. Avon flight experience was accumulated with the help of two Lancastrians, beginning in August 1948 and continued in a Meteor 4 and various Canberras.

Type-tested in mid-1951, the R.A.7 incorporated a number of refinements to give 7,500 lb. s.t. and was the first version with re-heat, which boosted the power to 9,500 lb. Rolls-Royce had previously developed re-heat on the Derwent in an experimental Meteor. A major re-design of the Avon, introducing the "cannular" combustion system instead of separate chambers, and other changes, produced the R.A.14, which was type-tested at 9,500 lb. s.t. in mid-1952, and a further advance has been made on this with the R.A.28, rated at 10,000 lb. s.t.

Other Avon variants include the R.A.9, a civil version of the R.A.3, of the same thrust, for the first Avon Comet; the R.A.16, a de-rated R.A.14 of 9,000 lb. s.t. for the prototype Comet 3; the R.A.21, an up-rated R.A.7 of 8,000 lb. s.t.; the R.A.22, an up-rated R.A.3 of 7,150 lb. s.t.; the R.A.25, a 7,000 lb. civil engine for the Comet 2 and the R.A.26, a civil R.A.28 of 10,000 lb. s.t. for production Comet 3s. Bristol, Napier and Standard Motors have established additional Avon production lines as part of the rearmament programme.

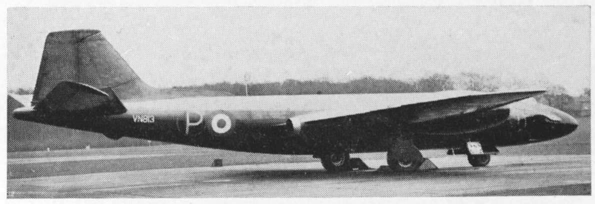


(Above) *Nene-powered Vampire F.2 (TX807) and* (below) *a similarly-powered Vampire (TG276) with modified intakes.*

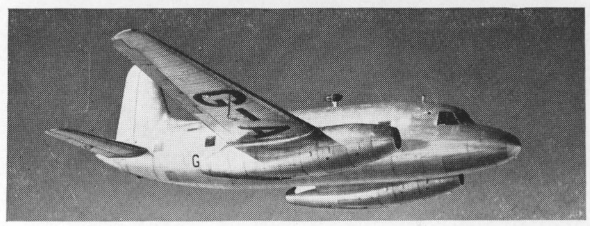


(Below) *Tudor Mk.8 (VX185) with four Rolls-Royce Nenes.*

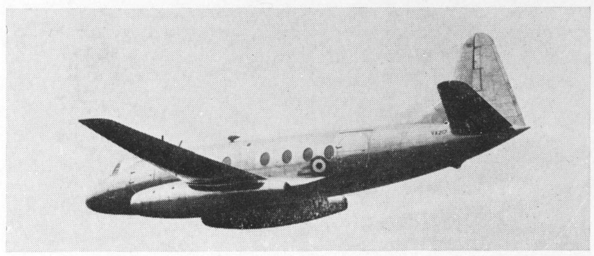
(Below) *Canberra B.1 (VN813) with Rolls-Royce Nenes.*



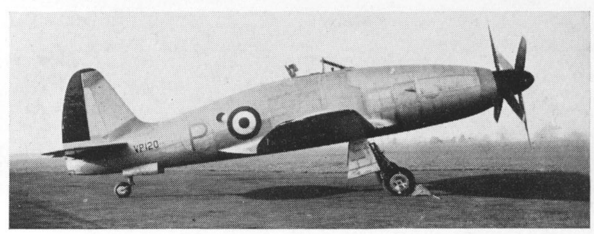
(Below) *Viking (G-AJPH) with Rolls-Royce Nenes.*



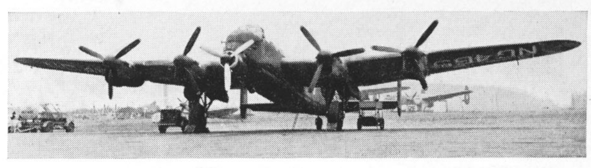
(Below) *Viscount Type 663 (VX217) with Rolls-Royce Tays.*

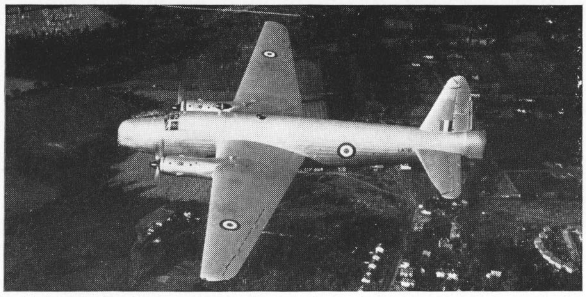


(Below) *Wyvern (VP120) with Rolls-Royce Clyde turboprop.*

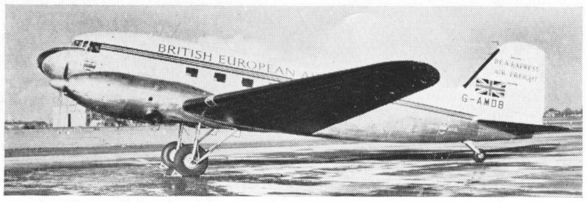


(Below) *Lancaster (NG465) with Dart turboprop in nose.*

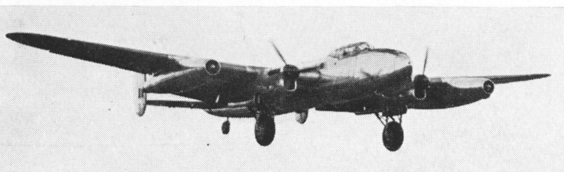




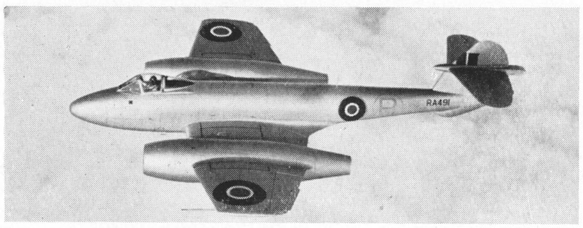
(Above) *Wellington B.10 (LN715) with two Dart turboprops.*



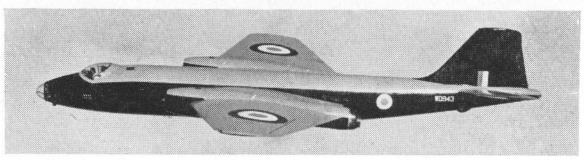
(Above) *Dakota (G–AMDB) with Dart turboprops.*



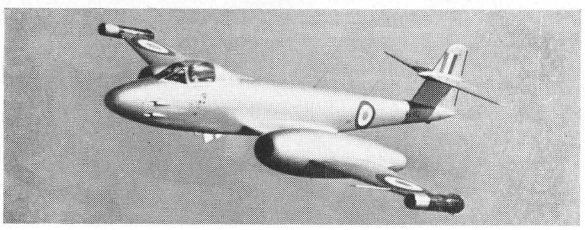
(Above) *Lancastrian (VM732) with Avons outboard.*



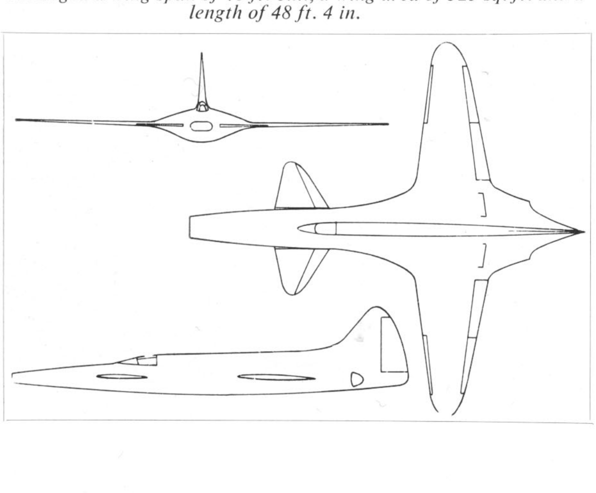
(Above) *Meteor F.4 (RA491) with Avons.*



(Above) *Canberra B.2 (WD943) with afterburning Avons.* (Below) *Meteor F.8 (WA982) with Soars at wingtips.*



General arrangement drawing of the projected Lockheed L–133 fighter of 1940. Of canard layout, this scheme for the L–133 envisaged a wing span of 46 ft. 8in., a wing area of 325 sq. ft. and a length of 48 ft. 4 in.



In August 1954 the existence of the RB93 Soar was made known. This is an axial turbojet delivering 1,810 lb. s.t. for the incredibly low weight of 267 lb., representing a power/weight ratio of 6·77 : 1. Two of these engines have been test-flown at the wing-tips of a Meteor 8. Future applications of the Soar have yet to be revealed.

In September 1954 news was first given of the Rolls-Royce work on jet lift. This development has initially taken the form of an elementary test rig mounting two Nenes end to end; the jet efflux from these engines is ducted through 90 degrees to exhaust downwards and provide direct lift. Control is derived from small nozzles supplied with air bled from the Nene compressors.

Tethered flight tests began in 1953, and the first true flight, untethered, was made by Captain Shepherd on August 3, 1954. Additional experiments in the use of jet lift for near-verticle take-off are now being made with a specially modified Meteor powered by two Nene engines.

Rolls-Royce are also continuing work on the RB82 Conway, a by-pass engine destined for the Vickers 1000. It has been running on the test-bed for some time and has a reported power of 10,000 lb. Other recent Rolls-Royce designs are the RB106, a 15,000-lb. twin-spool turbojet, and the RB109, a 4,000-e.h.p. supercharged turboprop which will shortly be test-flown in the outer nacelles of a Lancaster.

SAUNDERS-ROE

In connection with their helicopter development programme, the Saunders-Roe Helicopter Division has developed two pulse-jet units, similar in operating principles to the Argus 014 produced in Germany during the war. These units are the P.J.1 of 45-lb. thrust and the P.J.2 of 120-lb. thrust. Design of the P.J.1 began in March 1952, and the engine first ran on a test rig on August 21.

UNITED STATES OF AMERICA

Various companies and engineers in the U.S.A. considered gas-turbine engines in the between-wars period, but no serious proposals were made before 1939. In March of that year, Northrop proposed a large turbojet which was named the Turbodyne and for which a joint Army/Navy development contract was obtained in June 1941.

In 1940 Lockheed made their stake in the gas-turbine field with a design known as the L–1000, and, possibly for the first time in the U.S.A., the company initiated at the same time the design of a fighter aeroplane around this engine (thus exactly paralleling the history of the Halford H.1 and de Havilland Vampire). The L–133, as the aircraft was known, was intended to fly at 625 m.p.h. at 50,000 ft., representing a Mach number of 0·94.

In the event, neither of these engines was ever successfully developed, but the early awareness of airframe manufacturers, rather than engine manufacturers, of the potentialities of the gas-turbine, is of interest, and was also the case in Germany. Pratt and Whitney, however, had shown some interest prior to 1940, and in May 1941 this interest crystallized into design of an engine known as the PT–1, which utilized the exhaust of a two-stroke diesel to drive a turbine wheel which drove the propeller shaft.

Also involved in the early history in America were the Turbo Engineering Corporation (TEC) formed in 1937 to develop turbo-superchargers for piston engines, and the N.A.C.A. The TEC conducted investigations for the U.S. Navy into the possibilities of gas-turbine engines, and, as a result, eventually received a contract on October 19, 1942 for construction of a 1,100-lb.s.t. booster turbojet. This, in fact, was never built.

In 1936 the N.A.C.A. became very interested in the Campini system of using a piston engine to drive a ducted fan (see under Italy), and construction of an experimental engine of this kind, using a 600 h.p. Wasp piston engine driving a single-stage axial-flow ducted fan, began in 1940. This first ran successfully in January 1942 giving 600 lb. thrust. After an 825 h.p. R–1535 had been substituted, this thrust reached 900 lb. in October 1942, and 2,110 lb. could be obtained using "afterburning", which consumed 2·3 lb. of fuel per second. The engine was never flown and was abandoned in April 1943 because it was too heavy and the fuel consumption was too high.

Work on aircraft gas-turbines gained impetus from two happenings in 1941. One was the setting up of the Durand committee and the other was the importation of some early Whittle engines and drawings from Britain. The Durand committee, set up jointly by the U.S. Army Air Force and the U.S. Navy, included representatives of Allis-Chalmers, Westinghouse and General Electric—all experienced in industrial-turbine production but without preconceived ideas about aero-engine design. In July 1941 this committee recommended that each of these three companies should design a turbine engine and as a result of this, Westinghouse received a contract from the Navy on December 8, 1941 for a small booster turbojet (their Model 19A); Allis-Chalmers received a Navy

contract in February 1942 for the detailed design of a ducted fan, and G.E.C. received a U.S.A.F. contract for a turboprop engine (their TG–100, known to the U.S.A.F. as the T31).

In the spring of 1941 General Arnold, then C.-in-C. of the U.S.A.A.F., saw something of Britain's progress with turbojet engines, and it was primarily at his instigation that arrangements were made for a Whittle W.1X, a W.2B/23 and a set of drawings of the W.2B to be sent to America, together with a small team of Power Jets engineers. The General Electric company was initially entrusted by the U.S.A.A.F. with the development and production of engines of the Whittle type, and Bell were authorised to go ahead with design of a suitable fighter-type airframe.

AEROJET

Known principally for their work on solid-fuel assisted-take-off rockets this company is also now in production with liquid rocket engines for guided-missile propulsion (in air and water) and high-altitude research vehicles. The Douglas Nike and Firestone Corporal are among missiles having Aerojet liquid rocket engines. Another recent product is the YLR45–AJ–1, an assisted-take-off liquid rocket unit used on later models of the B–47.

Some ramjets have also been built by Aerojet.

ALLIS-CHALMERS

Progress with the Allis-Chalmers ducted-fan engine, ordered in February 1942, was slow and by the middle of 1943 construction had not even begun; the U.S. Navy then cancelled its contract. This left Allis-Chalmers free to undertake production of the de Havilland H–1B Goblin under licence, this engine being then envisaged as the power unit for the Lockheed F–80 Shooting Star. The subsequent availability of the General Electric I–40 of higher performance, however, led to this arrangement being terminated after seven H–1Bs had been completed under the designation J36. These were flown in the composite-powered Curtiss XF15C–1 and Grumman XTB3F–1.

ALLISON

This company became involved in gas-turbine manufacture in June 1944 when it was invited by the U.S.A.A.F. to produce the J33, then under design by the G.E.C. as the I–40. The first Allison J33 rated at 3,750 lb., was completed in January 1945 as the J33–A–4; arrangements were also made for Allison to produce the J31 (G.E.C. I–16) and the first of these was completed in May 1945.

After the end of the war development of Allison piston engines ended and in November 1945 the company assumed complete responsibility for the development and production of the J33. In May 1948 this engine, in its Allison 400 C4 (J33–A–25) version, became the first American turbojet to obtain C.A.A. approval for commercial use, but it has not in fact been so used. The first version of the J33 incorporating major Allison design modifications was the J33–A–17, produced in May 1946. This and the J33–A–21 were type-tested early in 1947 at 3,850 lb. s.t., and were followed by the more radically modified J33–A–23 which gave 4,600 lb. and enabled the Lockheed P–80R to set a new speed record on June 19, 1947 at 623·8 m.p.h.

Following their success with the J33, Allison next took over from Chevrolet production of the eleven-stage axial compressor J35 turbojet, designed by G.E.C. as the TG–180. In September 1946 the company assumed complete responsibility for this engine also. The first true Allison version was the J35–A–17 (Model 450), and steady development of the design has improved the basic thrust rating to 5,600 lb. s.t., to which an afterburner can be added.

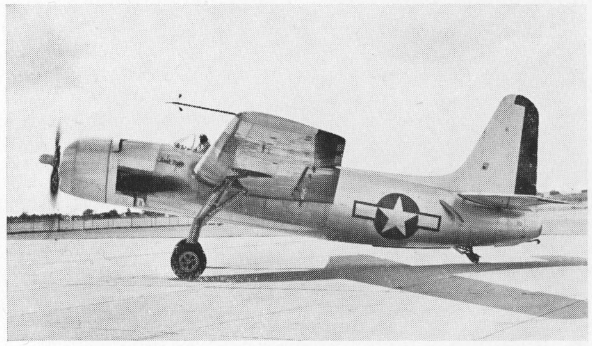
In August 1948 work on an almost complete re-design of the J35 began, and this first ran in April 1950. At first designated J35–A–23, it is now known as the J71, and is a sixteen-stage axial engine with a three-stage turbine and cannular combustion system. It is a high-compression, all-steel engine for supersonic and all-weather operation, rated at up to 10,000 lb. basic thrust, increasing to 14,000 lb. with afterburning.

Development of the J33 has also continued and Allison have re-designed the engine to permit a greater mass flow, so that a basic thrust of 6,350 lb. can be obtained, further augmented by afterburning.

In parallel with their work on turbojets, Allison initiated in 1944 an original line of development on turboprops. First of these engines was the T38 (Model 501), using a nineteen-stage axial compressor and a four-stage turbine and giving 2,925 e.h.p. This engine first flew in the nose of a B–17 in April 1949 and later powered a Convair 240, flown on December 29, 1950. Further use of this engine is being made for the flight-testing of supersonic propellers, in the McDonnell XF–88B.

As the T40 (Model 500), the basic engine has been compounded, this double unit giving 5,850 e.h.p. The first flight of the T40 was made in the Convair XP5Y–1 on April 18, 1950, and in the Douglas XA2D–1 on May 26 of that year. A special version of this engine, the YT40–A–14, has been developed to power the Lockheed and Convair vertical take-off

(Above) *Curtiss XF15C–1 with Allis-Chalmers J36 in fuselage.*



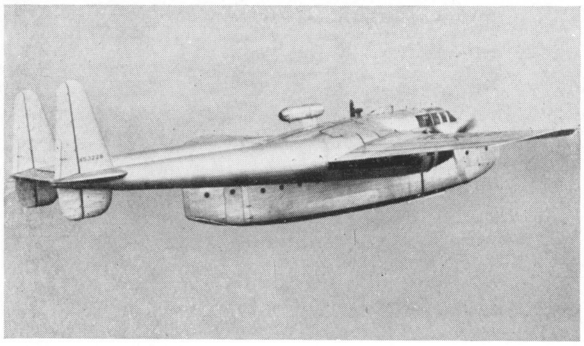
(Above) *Grumman XTB3F–1 with J30 in tail* (*later flown with J36*).

(Above) *Convair 240* (*N24510*) *with two Allison T38s.*

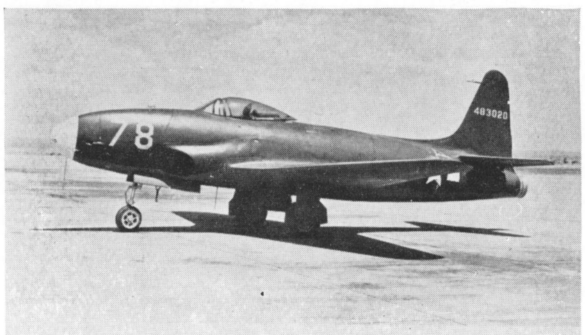
(Above) *Constellation* (*N67900*) *with Allison T56 outboard starboard.* (Below) *Convair YC–131C with two Allison YT56-A-3s.*

(Above) *B–45C Tornado (48–008) with Allison J71 turbojet.*

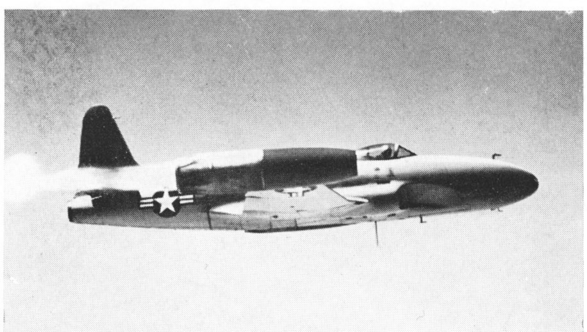
(Above) *Cessna XL–19B (52–1804) with Boeing T50 turboprop.*



(Above) *Fairchild Boxcar (N53228) with J44 above fuselage.*



(Above) *XP–80A (44–83020) with G.E.C. I–40 and* (below) *P–80A (44–85214) with Marquardt ramjets at wingtips.*



fighters, and gives 7,100 e.h.p. for the initial take-off period. The XT40–A–6 engine was used for the preliminary trials with these two aircraft. Another Allison turboprop design, the T44, was not built.

A forward development of the T38 is the T56, a 3,750 e.h.p. turboprop with fewer compressor stages and an annular combustion system. It was first flown in an outboard nacelle of a Super Constellation, and is now in production for the Lockheed C–130A, as well as powering the two Convair C–131Cs (YT56–A–3). An order for 288 T56–A–1 turboprops for C–130A transports was placed with Allison in September 1954. A paired version, the T54, is to be used in the Republic XF–84H test-beds for further supersonic propeller-testing and is the probable ultimate power plant for the V.T.O. fighters.

BOEING

This company of aircraft manufacturers founded a propulsion department in 1943, primarily as a research project. This research eventually reached the stage where two small engines, a turbojet and a turboprop, were built. These were known respectively as the Boeing Models 500 and 502, and were first publicly announced in September 1948.

The Boeing Model 500 uses a centrifugal compressor and a single-stage turbine. It delivered 210 lb. s.t., but has not been flown.

The Model 502, designated T50 by the U.S.A.F. and U.S.N., gives 210 s.h.p., and has been used to power the Cessna XL–19B light plane and two Kaman helicopters. Its general arrangement follows that of the Model 500.

CONTINENTAL

Well-known for their range of light-piston aero-engines, this company entered the gas-turbine field in 1952 by acquiring from Turboméca in France exclusive rights for the development in the U.S.A. of eight of that company's small gas-turbines.

The first of these engines to reach a production stage is the Marboré, which is being built for the Cessna T–37 and the Ryan Firebee. Original Continental versions are the J69–T–1 (Marboré I) of 660 lb. s.t., and the 69–T–3 (Marboré II) of 880 lb. s.t., but the engine has now been developed into the J69–T–19, giving 1,000 lb. thrust.

Much development is also being put into the Artouste turboprop, which, as the T51, has been test-flown in the Cessna XL–19C and the Bell XH–13F helicopter and powers the Sikorsky XH–39 helicopter.

FAIRCHILD

This company's engine division has in hand a number of secret development contracts concerned with unusual types of military engine. The only outcome of this work so far announced is the J44, a small expendable turbojet for guided missiles and target drones, used in the Ryan Firebee, ordered by the U.S.N. and U.S. Army. It features monocoque construction, in which the outer casing of the engine is an aerodynamic housing. The compressor is of the "diagonal-flow" type, with one centrifugal followed by one axial stage. The J44 gives 1,000 lb. s.t.

A new application of the J44 as a thrust booster for transport aircraft is being developed, with a single J44 mounted above the fuselage of a Fairchild Packet. Another interesting application is in the Bell V.T.O. research aircraft, which has one J44 on each side of the fuselage close to the C.G. These can be rotated through 90° to give vertical thrust for take-off and horizontal thrust for forward flight.

Another early Fairchild design, the T46 turboprop, was not continued.

In September 1954 the company won a U.S.A.F. design contest for development of a new light-thrust turbojet, which will probably be based upon the J44 and give about 2,000 lb. s.t.

FLADER

Only production engine developed by this company was the J55 (Type 124 Lieutenant) with a single-stage axial supersonic compressor. Intended for guided missiles, the J55 developed up to 1,100 lb. s.t. The company also designed one of the earliest turboprops against a U.S.A.F. contract, the XT33. This had a projected power of 7,500 e.h.p. but was not built.

GENERAL ELECTRIC COMPANY (G.E.C.)

General Electric had two separate departments working on gas-turbine design from 1941 onwards; the steam-turbine division concerned with the TG–100 of original design, and the turbo-supercharger department occupied with the imported Whittle design.

The first Whittle-type engine built in the U.S.A. was the G.E.C. Type I, run on March 18, 1942, twenty-eight weeks after work began. It was followed by the I–A, two of which were flown in a Bell P–59A on October 1, 1942 at Muroc—the first American jet flight.

In February 1943 a new engine designed to give 1,400 lb. thrust, the I–14, was first run, one month after design work on the 1,600-lb. s.t. I–16

began. The latter ran in April 1943 and also flew in the P–59A; in July 1943 one of these aircraft powered by I–16s reached 46,700 ft. The series continued with the 1,800-lb. I–18, run for the first time in January 1944, and flown in a P–59A in November of that year, and the 2,000-lb. I–20 run in April 1944. The I–16 was later redesignated J31–GE–3.

Finally came the I–40, using the compressor and turbine from the I–16 with a new straight-through combustion system, designed for 4,000-lb. thrust. It first ran on January 13, 1944, and was flown in the XP–80A on June 10, 1944, whereupon plans for the Goblin-powered P–80 were dropped (see Allis-Chalmers). In production, the I–40 was designated J33 (see Allison).

Meanwhile the steam-turbine division had continued work on the TG–100 (T31) but by May 1943 had succeeded only in running it without a propeller. In 1943 the division had proposed a new axial-flow turbojet based on the features of the T31, to meet the same requirements as the I–40. This was designated TG–180 (J35) and used an eleven-stage compressor. It ran on April 23, 1944, and was first flown in the XP–84 in February 1946, giving 4,000 lb. thrust. Work on the T31 slowed down and eventually stopped, but not before it had flown in the Convair YP–81 (on December 21, 1945) and the Ryan XF2R–1. Little development was undertaken on a later turboprop, the TG–110, or a "paired" version of this engine, the TG–120.

The next important General Electric engine was the TG–190, which was adopted by the U.S.A.A.F. as the J47 and has been one of the most successful of all American turbojets to date. Its design was based upon that of the J35, but the basic rating was boosted to 5,200 lb. s.t., subsequently increased by afterburning and other means.

The sub-variants of the J47 can be regarded in five different groups. The earliest models, in the A range, were rated at 4,850 lb., and those in the B range at 5,000 lb. The series known to G.E. as the C range had a basic rating of 5,200 lb., without afterburner, for which there was no provision. The D range, of which the J47–GE–17 was the first example, introduced the G.E.-developed afterburner and a larger compressor, giving a rated thrust of 7,200 lb.

In the E range several hundred changes have been made to produce an all-weather engine with, originally, a ten-per-cent thrust-increase over the C range, at 5,800 lb., or 6,500 lb. with water injection. The major engine in this series was the J47–GE–23, but this has now been superseded by the –25 for the B–47E, in which the dry thrust has been further increased to 6,000 lb. and the wet thrust to 7,020 lb. Versions of the engine basically similar to the GE–23 are also produced by Packard and Studebaker in large quantities, designated respectively J47–PM–25 and J47–ST–25.

Another J47, the GE–21, was a complete re-design "from the ground up" within the same general dimensions. After it had been built and tested, this engine was re-designated the J73. It is now in production with a basic power of 9,000 lb. s.t., rising to 12,000 lb. or more with an afterburner.

In 1949 design work began on a completely new large axial turbojet, the J53, and this has been the subject of intensive development. The design is based upon a thirteen-stage compressor, two-stage turbine and annular combustion chamber. This engine has given 23,750 lb. on test with an afterburner, but has been superseded by the J79. This is an all-steel, single-spool turbojet for supersonic flight, with a seventeen-stage compressor, the first five stages of which have electronically variable incidence. This engine, which will be the power unit of the supersonic Convair B–58A Hustler, has a basic dry-rating of 15,000 lb.

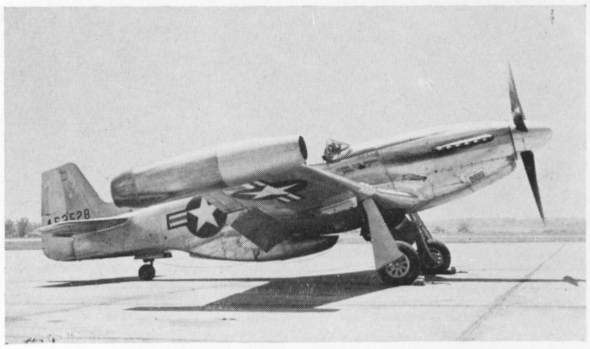
General Electric also have development programmes on the J77, of higher power than the J79; the X–25, a lightweight fighter engine in the 12,000-lb.-s.t. class, and the T58, a helicopter shaft-drive gas-turbine of 800–1,000 s.h.p., required by the U.S.N. for future helicopters. Turbojet, turboprop and ducted-fan versions of this design are reportedly being studied by the company.

In September 1954 the company was awarded a U.S.A.F. contract for development of a "light-thrust turbojet" of modern design.

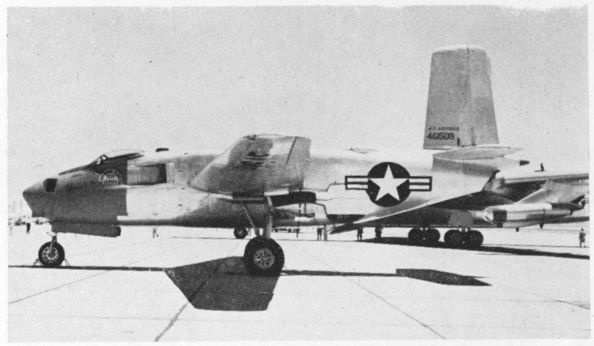
LOCKHEED

As previously related, Lockheed completed designs of their L–1000 in 1941, and submitted it to the U.S.A.A.F. in 1942. It did not receive official support until mid-1943, however, as a long-term project designated the XJ37. It promised to have a better specific fuel consumption than any other turbojet then designed, but was a complex engine requiring much development. Permission to develop the L–133 fighter airframe, designed around the L–1000, was never granted, however. Instead Lockheed were required to develop the XP–80 for the de Havilland Goblin to be built by Allis-Chalmers.

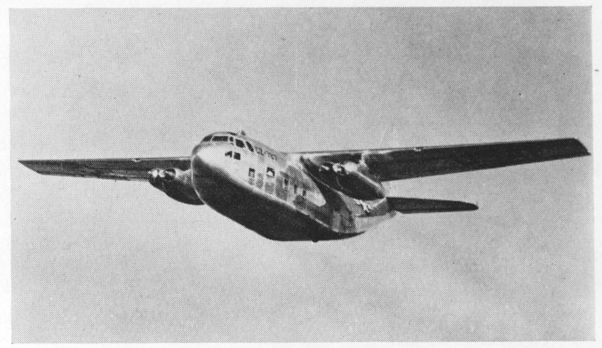
In October 1945 Lockheed decided to give up turbojet development and the XJ37, with its design staff, was transferred under licence to the Menasco Manufacturing Co. This company built the prototype XJ37, under the designation Lockheed L–4000, but had insufficient facilities to



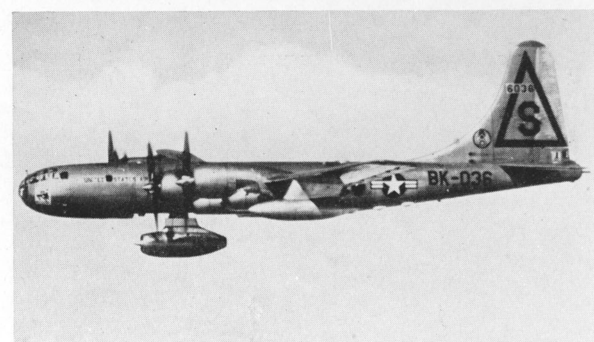
(Above) *F–51D Mustang (44–63528) with Marquardt ramjets.*



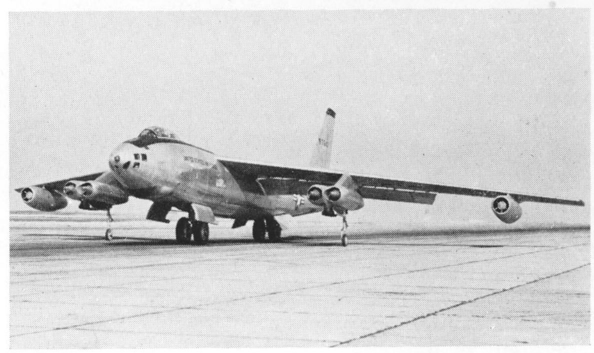
(Above) *YB–43 (44–61509) with one J47 and one J35 in fuselage.*



(Above) *Chase XC–6123A (47–787) with four J47 turbojets.*



(Above) *Boeing B–50 (46–036) with J57 below bomb-bay.* (Below) *Boeing B–47B (49–2643) with two J57 turbojets outboard.*



continue development, which was thereafter taken over by Wright Aeronautical, who continued with the work for some time but eventually abandoned development.

Recently Lockheed have begun development work on ramjets and rocket engines in connection with the work of a newly-formed missile division.

LYCOMING

This division of Avco Manufacturing Corporation has established a development team under Dr. Anselm Franz, formerly of Junkers. The T53 turboprop, a 1,000 s.h.p. engine for helicopters and fixed wing aircraft, is at present running on test.

MARQUARDT

In November 1944 the Marquardt Aircraft Company was formed with the primary object of developing ramjets for aircraft propulsion. This work had its first outcome in development of the Marquardt XRJ30–MA, the first successful American ramjet to be placed in production. The RJ30, or Marquardt C–20, was a 20-in. diameter subsonic unit developing 2,500 e.h.p., and was used in the Martin KDM–1 Plover target drone for the U.S. Navy.

Later, the C–30 and C–48, respectively of 30-in. and 48-in. diameter and higher power, were built, and two C–30s were mounted at the wing tips of a Lockheed F–80 for trials in 1947. This was probably the first piloted aeroplane in the world capable of flight on ramjet power alone. Later, an F–51 Mustang was similarly fitted for further trials.

The designation XRJ31–MA applies to a U.S.A.F. subsonic ramjet made by the company. Work on supersonic ramjets is going on, but details have not been made public, other than the fact that these engines are for use at speeds up to Mach 4·0 and have been test-flown on missile test beds.

Ramjets for helicopters have also been developed by Marquardt, and have been used in the Hiller Hornet and McDonnell XH–20. In 1954 the company developed a ramjet of aerofoil profile to be fitted in the tips of helicopter rotors for power boosting. Marquardt have also produced a range of valved pulse-jets for target drones and in 1948 flew their M–14 helicopter powered with two of these units. The MA–16 pulse-jet has operational efficiency at Mach 0·45 and a ceiling of 15,000–20,000 ft. The company's pulse-jet in the Globe KD5G–1 drone is designated the PJ46–MA–2.

The company is engaged on development of afterburners for advanced turbojet engines.

NORTHROP

Following Northrop's early interest in a large turboprop, already noted, the company received a contract for two complete engines, eventually rated at 3,800 e.h.p., on July 1, 1943. The first of these ran on the stand in December 1944, and was the first American turboprop to run with propeller attached. It was named the Turbodyne and as originally built had an eighteen-stage compressor and a four-stage turbine.

In 1944 Northrop had joined forces with the Joshua Hendy Iron Works to form the Northrop-Hendy Co., which pursued development of the Turbodyne designs. During 1945 the U.S. Navy withdrew its interest, and the U.S.A.A.F. then issued a new contract calling for the design and construction of a much larger edition of the engine, designated the XT37.

In 1948 Northrop acquired the Hendy shares in the joint company, which was re-named the Turbodyne Corporation. In 1950, the XT37 passed a 50-hr. type-test and had by then produced more than 10,000 e.h.p. Later in that year, the patents, name and technical data of the Turbodyne company were acquired by G.E.C. The flight trial stage was reached with the engine, installed in a Northrop B–35, but a long succession of development troubles led to its eventual adandonment.

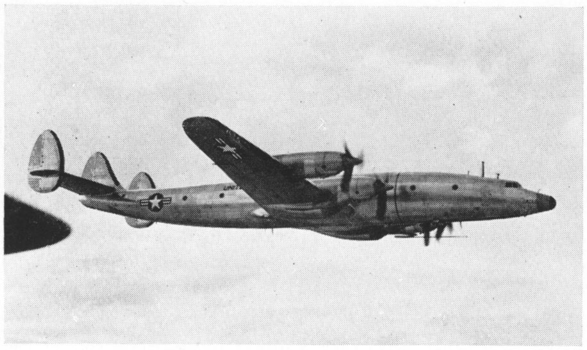
PRATT AND WHITNEY

The 5,000 h.p. PT–1, already mentioned, remained under development throughout the war as a long-range applied research project. The free-piston diesel compressor proved to be the most difficult part to develop. On June 30, 1945 a U.S. Navy contract was placed covering the cost of all future development and a complete engine was laid out and built for flight tests. By the time it had been constructed, however, turboprops were available to give the same power with less development, and the PT–1 was not in fact flown.

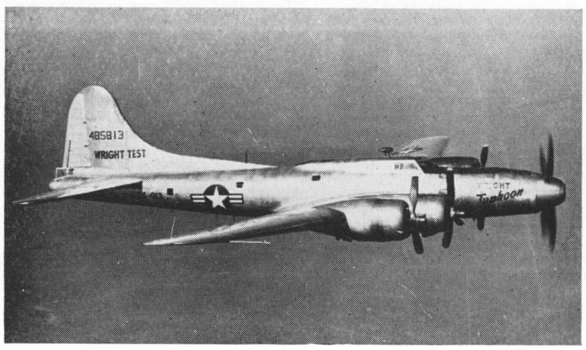
About this time Pratt and Whitney built their first turbojets as sub-contractors to the U.S. Navy. In early 1945, 500 Westinghouse J30s were ordered from Pratt and Whitney for the McDonnell FH–1; this contract was reduced to 130 after V.J. Day, and these engines were completed during 1947. Early in 1946, another U.S. Navy contract called for development of a large turboprop engine, the T34, which was also to be available as a paired unit (the T32). This project took the company designation PT–2, and flight tests of the T34, rated at 5,700 h.p., began in the nose of a B–17 in August 1950.

(Above) *Boeing Model 299Z (N5111N) with T34 in nose.*

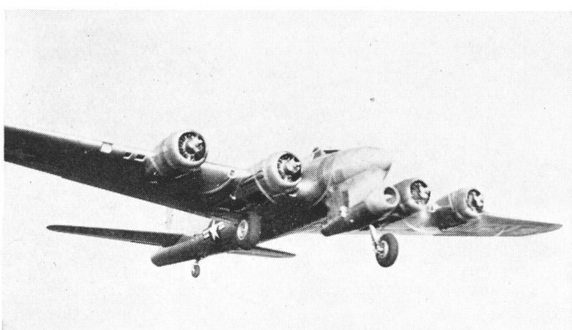
(Above) *Douglas YKC–124B (51–072) with four T34 turboprops.*



(Above) *Lockheed R7V–2 with four T34 turboprops.*



(Above) *Boeing B–17G (44–85813) with Wright T35 in nose.*
(Below) *B–17G with J65 turbojet under the nose.*



Work on turbojet engines began also in 1945. Pratt and Whitney chose an axial design and aimed at 7,500 lb. s.t. to start with. With a U.S.A.F. contract to cover the proposal, serious work began in the autumn of 1947 and this led in due course to the appearance of the J57 (JT–3), first flown beneath a B–50 in March 1951.

Meanwhile, Pratt and Whitney had become intimately associated with Rolls-Royce turbine engine development. This came about in late 1948 when the U.S. Navy realised that the Nene was a readily-available developed engine of higher power and better all-round performance than any American engine then in production. An option on Nene production was already held in America by the Taylor Turbine Corporation, which had imported some Derwents and Nenes and planned eventually to manufacture Rolls-Royce designs. As Taylor could not produce in quantity immediately, however, the U.S.N. persuaded the Corporation to release its option to Pratt and Whitney, who concluded the necessary agreements with Rolls-Royce in May 1947. The Nenes imported by Taylor were designated YJ42–TT–2.

Designated J42 (JT–6), the first Pratt and Whitney Nene ran on test in March 1948 and completed its 150-hr. acceptance test in October at 5,000 lb. s.t. dry and 5,750 lb. s.t. with water injection. Many hundreds were produced, primarily for early versions of the Grumman F9F Panther.

Working closely with Rolls-Royce, Pratt and Whitney set about developing the Nene to increase its power by thirty per cent and to introduce an afterburner. This led to the J48 (JT–7), known in England as the Tay. This engine was flying by the end of 1949 in the F9F–5 and in its later versions is rated at 7,250 lb. s.t. dry and 8,500 lb. s.t. with afterburning.

The J57, already mentioned, is a more up-to-date engine than the Nene or Tay, being more comparable with the Rolls-Royce Avon. The Pratt and Whitney agreement with Rolls-Royce, incidentally, covered only Whittle-type engines developed by Rolls-Royce, and therefore excluded the axial Avon. The J57 is a twin-spool engine with an all-steel compressor and cannular combustion, with a present rating of 10,000 lb. s.t. The Pratt and Whitney afterburner for the J57 is expected to increase the thrust of developed versions in the future to a maximum of 15,000 lb. A development of the design, the J75, has been running on the bench and is expected to give 15,000 lb. s.t. basic and up to 21,000 lb. s.t. with afterburning. The J57 is also being produced by Ford, in the 14,000 lb. J57–F–7 and, more recently, the J57–F–13, afterburning versions.

Turboprop development, begun with the T34, was continued with the T48 and T52, with powers of 9,860 e.h.p. and 8,500 e.h.p. respectively, but the T52 was officially abandoned late in 1954. Latest Pratt and Whitney turboprop design is the 15,000 e.h.p. T57 for the Douglas C-132.

REACTION MOTORS

This company was formed in December 1941 to continue the pre-war work of four members of the American Rocket Society, and has probably more experience in the liquid rocket field than any other company in the world. It has produced many experimental rocket engines using various fuels and has a large production output of engines for guided missiles and such test vehicles as the Martin Viking and the Convair MX–774 (with an 8,000-lb.-thrust rocket engine).

The Model 6000C4, designated XLR–11 by the U.S.A.F., is best known of the aircraft rockets, and runs on liquid oxygen and ethyl alcohol. It has four chambers, which may be fired independently or together, and produces 6,000 lb. thrust maximum at any altitude. The XLR–11 is used in the Bell X–1 series and the Republic XF–91.

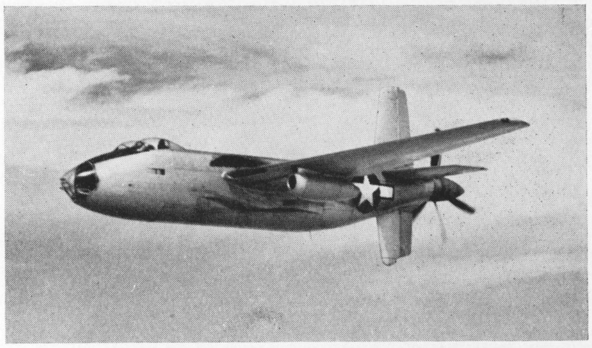
Another aircraft rocket is the 6,000-lb. thrust XLR–8, which is used in the Douglas Skyrocket, while the XLR–10 gives a thrust of 20,500 lb. from a single chamber and is used in the Martin Viking. At the other extreme, Reaction Motors have more recently developed the XLR32–RM, which weighs only 1 lb. and is used in the Rotorcraft RH–1 Pinwheel and Kellet KH–15 helicopters. The XLR–32 has also been successfully applied to the rotors of a Sikorsky HRS–2 as a means of boosting take-off power.

WESTINGHOUSE

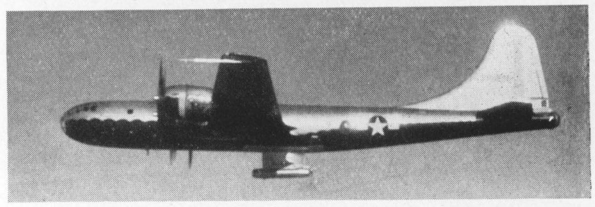
As noted already, Westinghouse were one of the three turbine-manufacturing companies invited to join the Durand committee, and were thereafter authorised by the U.S. Navy to proceed with design of a small booster turbojet. This engine had the company designation X19A and was an axial design with six stages and a single-stage turbine. It first ran on March 19, 1943, giving 1,200 lb. s.t., and the second engine was test-flown beneath a Chance Vought F4U Corsair on January 21, 1944.

A development of the design for use as a primary power unit rather than as a booster, was developed as the 1,300-lb. s.t. X19B, first run on March 14, 1944, and put into production for the U.S.N. as the J30. A Martin JM–1 Marauder was modified for continued flight trials.

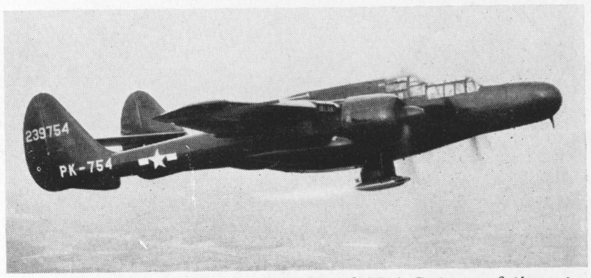
A much smaller engine, the Model 9, was also derived from the Model 19, and was put into production as the 275-lb. s.t. J32 for guided missiles, and target drones such as the TD2N. The Model 19 was further developed



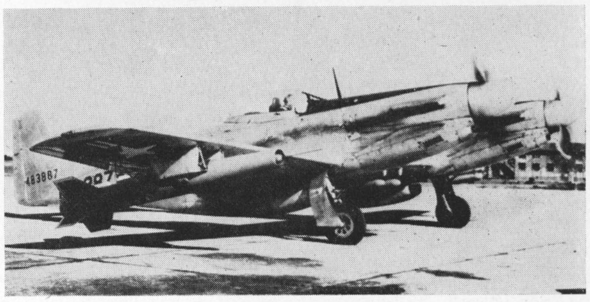
(Above) *Douglas XB–42A (43–50224) used for turbojet testing.*



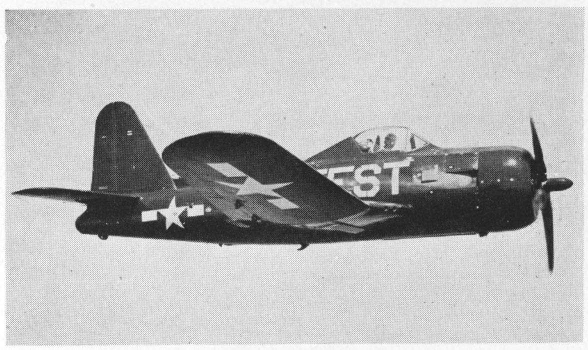
(Above) *B–29 (45–21808) with 20-in. N.A.C.A. ramjet.*



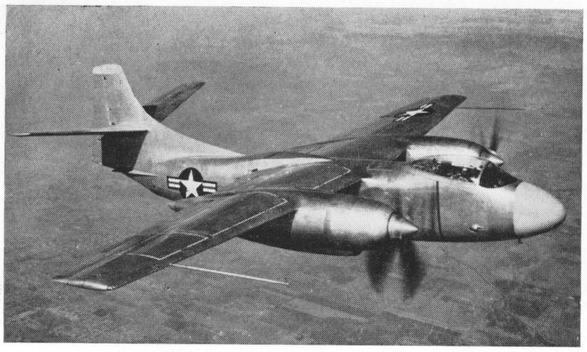
(Above) *Northrop F–61 (42–39754) with N.A.C.A. aerofoil ramjet.*



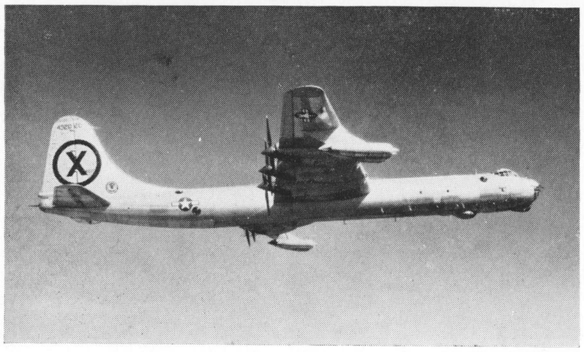
(Above) *F–82 Twin-Mustang (44–83887) with N.A.C.A. ramjet drop-missile.*



(Above) *Ryan FR–1 Fireball with J31 in rear fuselage.* (Below) *P4M–1 Mercator with J33 in rear of each engine nacelle.*

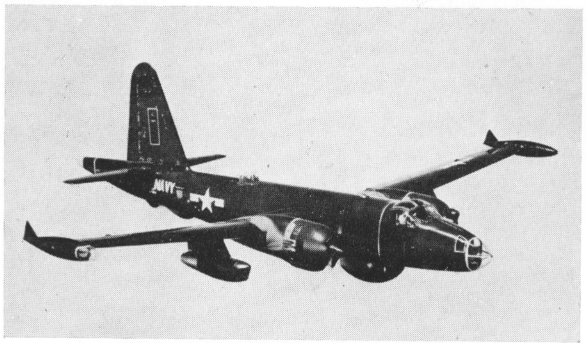


(Above) *XAJ–1 Savage with J33 in rear fuselage.*

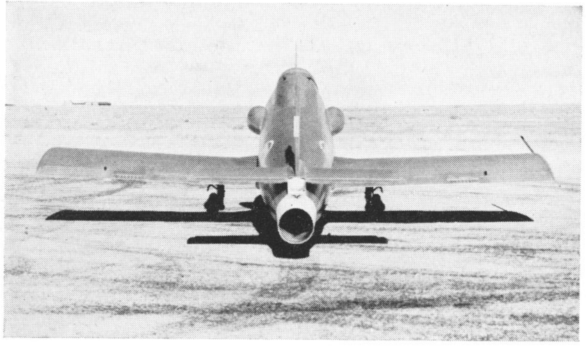


(Above) *Convair RB–36E with four J47s for take-off and combat.*

(Above) *Lockheed P2V–5 with J34s under wing for trials and* (below) *P2V–7 with J34s for combat power boosting.*



(Below) *D.A.P. Pika (A93) with Armstrong Siddeley Adder.*



during 1944 into the larger Model 24C with an eleven-stage axial compressor and a two-stage turbine. This was produced as the J34. First production model was J34–WE–22, rated at 3,000 lb. s.t. in May 1946, and the J34 now gives up to 4,200 lb. s.t. with an afterburner. The J34 received C.A.A. type certification for commercial use as the Westinghouse Model 24C–4D. A proposed turboprop version, the T30 (Model 24D), was not built.

Under Navy sponsorship, Westinghouse have continued the line of development with two further axial designs, the Model 40E (J40), giving up to 11,600 lb. s.t. with afterburner, and the J46, directly derived from the J34 and giving 6,000 lb. with afterburner. Production of these engines has been limited, and further work has been largely abandoned because of serious development troubles.

Mainly because of this failure, Westinghouse negotiated an agreement with Rolls-Royce Ltd. on June 15, 1953, for technical collaboration and this agreement is now bearing fruit in the development of new engines. There is no plan at present for the production by Westinghouse of original Rolls-Royce designs as such, but two R.R. Soar turbojets were supplied to Westinghouse at the end of 1954 for study, and the Soar is being sold through Westinghouse to Radioplane Company, a subsidiary of Northrop, for installation in a U.S.A.F. supersonic target plane.

Westinghouse are working on development of two new turbojets as private ventures. One is in the 15,000-lb.-thrust class, and the other will give 1,500–2,000 lb. s.t. and may be comparable to the R.R. Soar in design and application.

WRIGHT

This company of piston aero-engine makers entered the gas-turbine field comparatively late in 1945, with the design of a 5,000 plus e.h.p. turboprop. Flight tests of this engine, the XT35–W–1, began in the nose of a Boeing B–17 in September 1947, but after seventeen of these engines had been built the U.S.A.A.F. contract was cancelled. As already noted Wright also assumed responsibility from Menasco for the final development of the Lockheed XJ37 turbojet. Work on this engine stopped in 1950.

Little success attended Wrights early work on turbojets of their own design, either. Two such engines, the J59 of 12,000 lb. s.t. and the J61 of 11,000 lb., were planned in 1949, but both were subsequently abandoned.

In order to make up lost ground, Wright then negotiated with Armstrong-Siddeley and Bristol in this country, leading to licences for the manufacture in America of the Sapphire, Mamba and Python, and Olympus engines. Work began at once to "Americanize" the Sapphire, which has gone into production as the J65 for a number of aircraft of advanced design, and many hundreds of which have now been built. Buick Motors are also producing the engine in the J65–B–3 version. The J65–W–2 is rated at 7,200 lb. s.t.; the J65–W–4 is rated at 7,800 lb. s.t.; and the J65–W–7 is rated at 7,500 lb. s.t. No work has been done on the Armstrong Siddeley turboprop designs.

Under the designation J67 (Wright JT–32–B) the Olympus is being extensively developed to give a thrust of 12,000 lb. initially and up to 25,000 lb. s.t. with afterburning ultimately.

Turboprop versions of both the Sapphire and Olympus are being developed by Wrights, in conjunction with Curtiss-Wright supersonic propeller development. The T49, derived from the J65, began bench tests at the end of 1952, and is shortly to fly in a B–47. It is rated at 8,000 e.s.h.p. at sea level. The T47, turboprop version of the J67, is less advanced.

Another Wright section—Curtiss-Wright propeller division—is currently involved in the development of a throttleable liquid-fuel rocket, intended to power the Bell X–2. Designated the XLR25, this unit develops 12,000 lb. thrust.

OTHER COMPANIES

Several other American companies have from time to time projected or built gas-turbines but are not now actively engaged in the design field. These include Packard Motor Car Co., whose contract for development of the J49, expendable lightweight turbojet for pilotless aircraft, was cancelled by the U.S.A.F. in January 1949; Chrysler Engineering Corporation, whose work on the T36, 1,000 h.p. turboprop was cancelled in 1949; Jharl, whose Model 6000XA turbojet was abandoned; De Laval Steam Turbine Co., who did some work for the U.S. Navy on the T42 turboprop, and West Engineering Company, whose U.S. Navy contract for development of the J38 turbojet was likewise cancelled. The Ford Motor Company built Argus-type pulse-jets under the designation PJ31, for use in the KUW–1 drone.

ARGENTINA

The Institute Aerotecnica at Cordoba has a licence for production of the Rolls-Royce Derwent 5 and Nene 2, but little work appears to have been done on either of these engines.

AUSTRALIA

No turbojets of original Australian design have so far been developed, but licences have been obtained by Commonwealth Aircraft Corporation Pty Ltd., from Rolls-Royce Ltd. Initial production at the Lidcombe factory was devoted to a batch of Nene 2–VH engines for Australian-built Vampires. This is now being followed by the Avon R.A.7 for the Australian-built Sabre and Canberra.

BELGIUM

Fabrique National des Armes de Guerre obtained a licence in May, 1949 for production of the Derwent, required for Fokker-built Meteors. The first all-Belgian Derwent 8 completed its trials on February 21, 1951, and production is continuing The F.N. factory is now preparing for production of the Avon R.A.21 and R.A.23 to be used in Dutch- and Belgian-built Hunters.

CANADA

Research and development of gas-turbines began in Canada in August 1944 when Turbo-Research Ltd. was formed by the government. This company was taken over in 1946 by Avro Canada to become that company's engine division, and construction proceeded on the Chinook, a research turbojet. This used a nine-stage axial compressor and single-stage turbine and developed 2,900 lb. s.t. The first run was made on March 17, 1948 and much useful data was gathered. Within twenty months the Chinook completed more than 1,000 hrs. running and the thrust rose from 2,600 lb. to well over 3,000 lb.

At the request of the R.C.A.F. in 1946 Avro Canada began design of the Orenda, the first major Canadian turbojet. It is a single-shaft engine with a ten-stage axial compressor and a single-stage turbine. The first run was made early in 1949, and by the end of that year the prototype had completed 150-hr. R.C.A.F., M.o.S. and U.S. type-tests, Canadian and U.S. 50-hr. preliminary flight tests, and other special category tests. The first flight was made in July 1950 in a Lancaster and the first flight on its own power in the Sabre Mk. 3 in October 1950.

The first production engine, the Orenda 2, passed its type-test in February, 1952, and was used in the Avro Canada CF–100 Mk. 2. It was rated at 6,000 lb. and was soon followed by the 6,500 lb. thrust Orendas 8, 9 and 10, used respectively in the CF–100 Mk. 3, CF–100 Mk. 4 and the Canadair-built Sabre Mk. 5. Later engines such as the Orenda 11 and 14 are rated at 7,000 lb. and 7,275 lb. respectively, the former being intended for later versions of the CF–100 Mk. 4, and the latter for the Sabre Mk. 6.

Work continues also on the P.35, a big new axial turbojet in the 15,000 lb. basic thrust class. If successful, this engine, which will probably be named the Waconda, is likely to power production models of the new CF–105 all-weather fighter.

Rolls-Royce of Canada Ltd. are at present engaged in production of the Nene 10 required for the Canadair-built T–33A–N Silver Star Mk. 3.

FRANCE

Several French engineers had given attention to the possibilities of gas-turbines for aircraft during the 'thirties, but no such engine had been built up to the time of the German occupation, which naturally disrupted the work then in hand. Clandestinely, one or two groups of engineers managed to continue development of turbojet and turboprop designs, including a little construction, but France was far behind Britain, Germany and America by 1945, and this gap has not yet been closed, although it has narrowed.

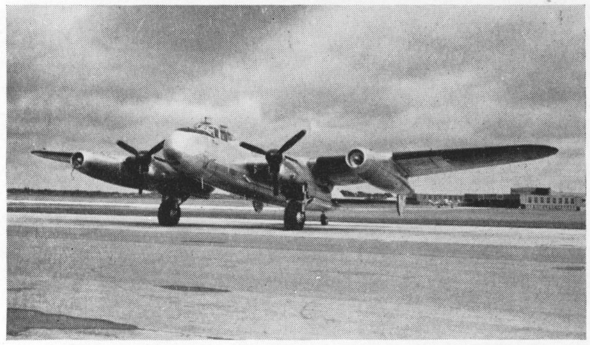
In the immediate post-war period French aircraft designers relied heavily upon captured German and imported British gas turbines, while the engine companies set about constructing a range of engines of original French design—and drawing freely upon German experience.

DASSAULT

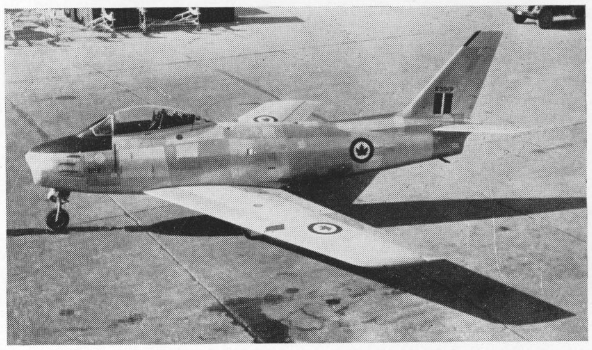
This aircraft manufacturing company has a licence from Armstrong Siddeley for production of the long-life Viper turbojet, and is working initially on the A.S.V.7R version with re-heat. This engine is to be used in the Dassault M.D.550 delta-wing light fighter.

HISPANO-SUIZA

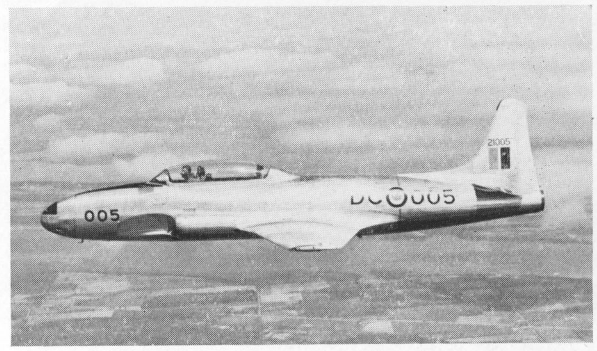
In 1946 this company signed a licence agreement with Rolls-Royce for production of the Nene, and for the past eight years has subjected this engine and its descendants to intensive development. Initially, the 4,850 lb. s.t. Nene 101 and the 5,000 lb. s.t. Nene 102 were produced. These have been followed by the Nenes 104 and 105, giving, respectively, 5,070 lb. and 5,180 lb. thrust and making more use of magnesium than



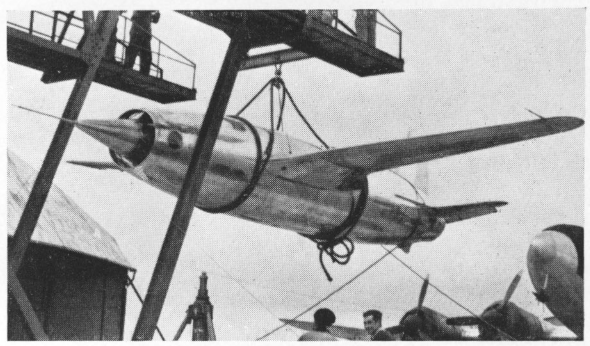
(Above) *Lancaster 10–O (FM209) with Orendas outboard.*



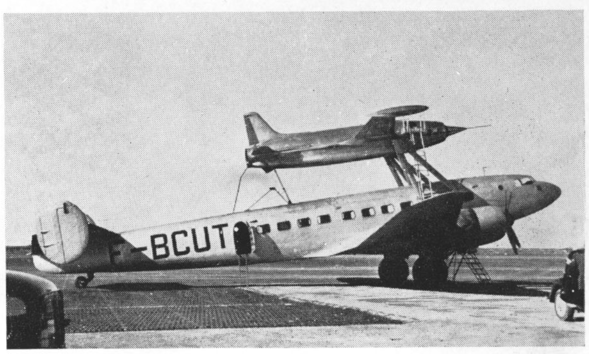
(Above) *Canadair Sabre Mk. 5 with Orenda 10 turbojet.*

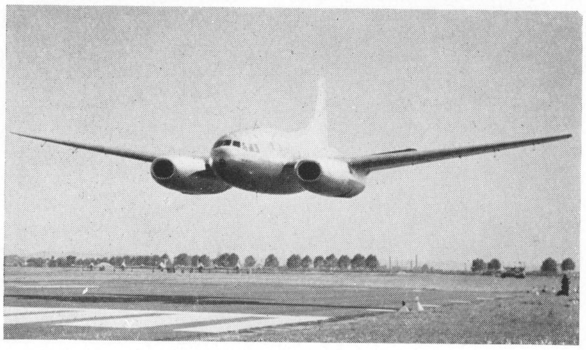


(Above) *Canadair T–33A–N Silver Star Mk.3 with Nene 10.*

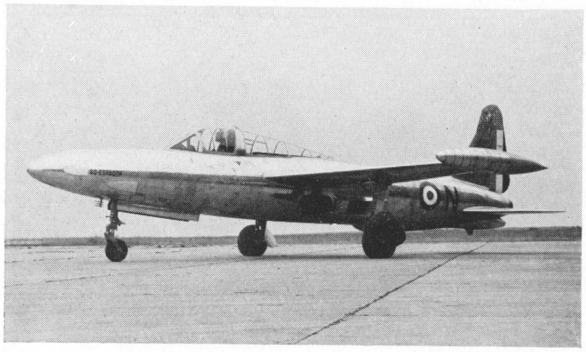


(Above) *Leduc 010–01 and,* (below) *Leduc 016–01 each powered by the Leduc ramjet unit.*

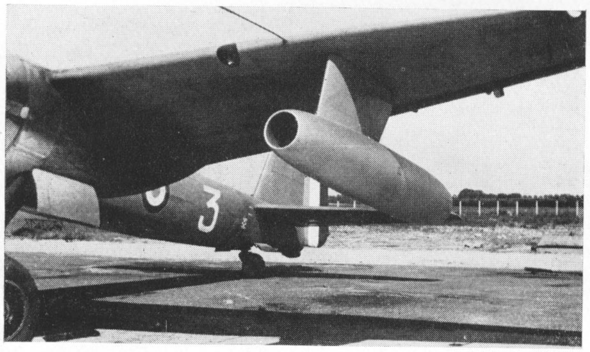




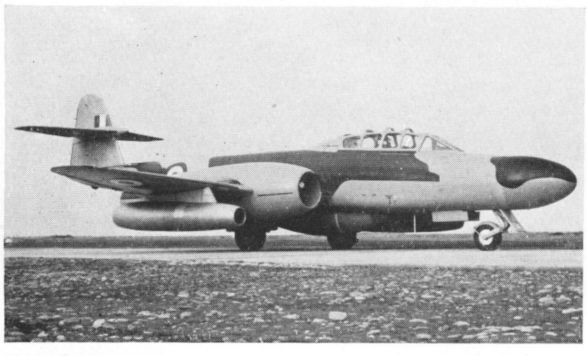
(Above) *S.O.30R (F–WAYB) with Hispano Nene turbojets.*



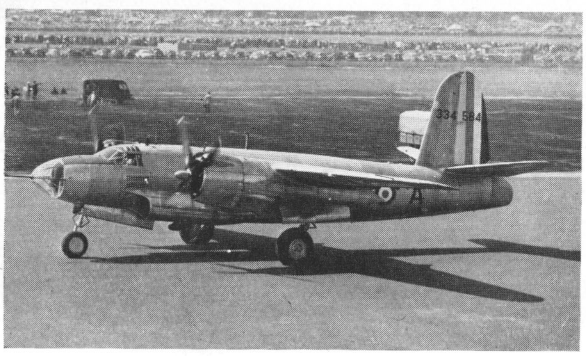
(Above) *S.O.6026 Espadon with S.E.P.R.251 rocket.*



(Above) *SFECMAS 600 ramjet fitted under wing of Ju 88G.*



(Above) *Meteor N.F.11 (NF11–3) with SFECMAS 600 ramjets.*
(Below) *Martin B-26C Marauder (43–34584) with Atar 101 in fuselage.*



the British engines. An afterburner was also developed for the Nene and boosted the thrust to 6,800 lb., but this engine, the Nene 102B, remained experimental only.

An all-French development of the Nene was built as the R–300, which, with the same overall dimensions as the Nene, produced 5,940 lb. s.t. as a result of an increase in the air mass flow. When a licence was signed in 1951 for production in France of the more powerful Tay, development of the R–300 was discontinued.

The French Tay is known as the Tay 250, and in its present production form for the Dassault Mystère gives 6,280 lb. s.t. Following the practice with the Nene, Hispano-Suiza set about developing the Tay to its limit, and have produced the R–450 Verdon, one of the best centrifugal engines produced to date, with a thrust of 7,720 lb. An afterburner has also been developed for the Verdon, boosting the power to 9,920 lb. s.t., and this afterburner was also applied to the Tay 250R, flown in a Dassault Ouragan. The Verdon has interchangeable mountings with the Tay and is now in production for the Mystère IVA.

Hispano-Suiza now have a licence for production of the Rolls-Royce Avon, which is required for the Mystère IVB, Sud-Ouest Caravelle and the Hurel-Dubois H.D.45.

LEDUC

M. Rene Leduc started work on his propulsive system for ram-jet aircraft as long ago as 1929, and has continued steadily ever since, with limited official encouragement and support. In the Leduc aircraft, the fuselage itself forms the propulsive duct, and is divided internally into several concentric diffusers, each with a series of fuel injectors round the leading edge.

As ram jets will operate only at fairly high subsonic speeds and above, some means of assisted take-off is necessary. The five Leduc research aircraft built to date have all been air-launched from a Languedoc, but a new prototype now being built, intended for use as a fighter, will include an Atar 101 in the fuselage for take-off purposes. Apart from wing sweepback, it will be generally similar in appearance and size to the latest prototype to fly, the 021–02, which develops about 15,000 lb. thrust at a high subsonic speed.

RATEAU

Development of aircraft gas turbines by this company began in 1939 and continued under great difficulties during the Occupation. Immediately after the end of the war, with Air Ministry backing, construction began of the SRA–1 turbojet. This was an axial engine with a sixteen-stage compressor and a two-stage turbine, and it featured the by-pass principle, in which secondary air by-passed the twelve high-pressure compressor stages and rejoined the gas stream behind the turbine. It developed 3,520 lb. s.t. with afterburning, and passed its type test in February 1947, but did not go into production.

This engine was followed by the SRA–101 Savoie, which is an all-steel engine with some advanced features allowing for its early design. It has a ten-stage axial compressor and two-stage turbine, and features variable tailpipe area. The Savoie gives 8,800 lb. s.t. with water injection and has completed much successful bench running, but has yet to fly.

SEPR (Société d'Etude de la Propulsion par Reaction)

French interest in rocket propulsion for interceptors and guided missiles is almost entirely dependent upon the work of this company, which specializes in bi-fuel rocket engines. Guided missile units are represented by a 2,750 lb. liquid fuel unit, having a burning time of fourteen seconds and powering the 1,100 m.p.h. Matra M.04 test vehicle.

The SEPR 251 is the first interceptor rocket engine, test flown in the SO 6025 and SO 6026 Espadon. It uses alcohol or petrol as the fuel with nitric acid oxidant, and has a full throttle thrust of 3,000 lb. A triple-barrel unit based on the SEPR 251 is now being flown in the SO 9000 Trident.

SFECMAS (Société Française d'Etudes et de Constructions de Matériels Aéronautique Spéciaux)

This company came into existence at the end of 1952 to take over much of the special development work of the national Arsenal de l'Aéronautique, when it ceased to function. Among present developments are a range of ram jets, and a pulse jet based on the Argus 014, with a thrust of 396 lb.

Among the ram jets are the S.600 which delivers some 1,320 lb. thrust at 621 m.p.h., and the S.900 giving 2,510 lb. at the same speed. The S.600 has been flown on a Junkers Ju 88G and a Gloster Meteor N.F.11. Work on supersonic ram jets is proceeding.

SNECMA (Société Nationale d'Etude et de Construction de Moteurs d'Aviation)

This is the principal nationalized French engine company and is responsible for development and production of the Atar 101 series of engines.

The Atar (from Atelier Technique Aéronautique Richenbach, a B.M.W. plant near Lake Constance during the German occupation) was based originally by Dr. H. Oestrich on the B.M.W.003, but is much enlarged and developed. The Atar 101 first ran in 1948 and the 101B passed a type test at 4,850 lb. in 1949. Its thrust later rose to 5,280 lb.

The Atar 101C of 6,200 lb. was the first production model and was quickly followed by the 101D, a fully developed production version, rated at 6,600 lb. and used in the Dassault Mystère IIC and several prototypes. The Atar 101E introduced water injection and some small refinements to boost the thrust to 7,300 lb.

SNECMA have developed an afterburner for the engine, these versions being the 101F (based on the 101D) of 8,380 lb. s.t. and 101G (based on the 101E) of 9,260 lb. s.t. The 101F first flew in a Mystère on February 21, 1954. The Atar is also being developed for vertical take-off applications, for which it has a weight/thrust ratio of 0·23:1.

A major development of the Atar 101, with which SNECMA are now occupied, is the Vulcain, a much larger single-spool turbojet designed to be suitable for a wide range of applications including fighters and long-range aircraft. Design began in June 1951 and the prototype first ran on May 21, 1952. Ground running has continued, to bring the Vulcain up to its present rating of 11,000 lb. s.t., and flight trials will begin soon in a Sud-Est Armagnac.

SNECMA are also developing a medium-powered turboprop, the TB 1000, which is an original Rateau design. This uses a nine-stage axial compressor and a two-stage turbine. It is rated at 1,600 e.h.p. for take-off, but this engine has not yet flown. Another, more recent, project is the development of the SNECMA R–105, a 3,000 lb. s.t. light-weight turbojet.

SNECMA have had considerable success in the development of Bertin-type valveless pulse jets, in which thrust is obtained purely by resonance controlled by the precise profile design inside the duct. The first such SNECMA pulse jet was the Escopette Type 3340, a group of four of which were first flown on an SA 104 Emouchet on November 30, 1950. This used a "recuperator", or U-shaped tube, at the front intake, to utilise as thrust any gas expelled from the intake, and gave about 22 lb. thrust. A similar design of higher power, the Tromblon, was also successfully test flown.

The Ecrevisse is a further development in which the duct is doubled back on itself so that both intake and propelling nozzle face rearwards. The Ecrevisse Type A has a power of 44 lb. and the Type B gives 66 lb.

SOCEMA (*Société de Construction et d'Equipements Mecanique pour l'Aviation*)

Design of this company's first gas turbine, the TGA 1 turboprop, was undertaken by a group of engineers from 1941 onwards, in complete ignorance of British and German work and without German knowledge. After the war, the design was modified to the TGA 1 bis and was built. It used a fifteen-stage axial compressor and a four-stage turbine and was rated at 5,570 e.h.p. Several prototypes were built and run on the bench with success but no flight trials were made.

In 1945, at the request of SNCASE, SOCEMA began design of a turbojet of 4,180 lb. s.t., the TGAR 1008. This has an eight-stage axial-flow compressor and a single-stage turbine, and uses an annular combustion chamber. The TGAR 1008 passed a 150-hr. type-test at 4,620 lb. s.t. and a later development, the TR 1008, has a thrust of 5,500 lb. s.t.

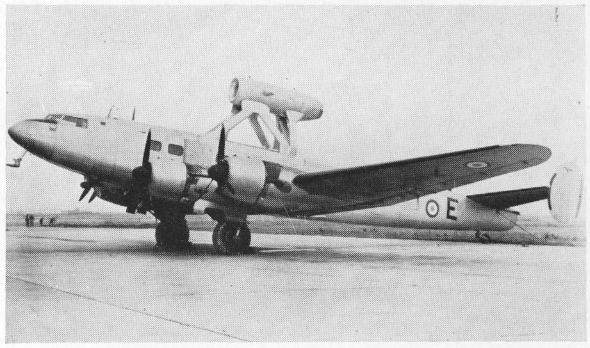
TURBOMÉCA

This company was formed in 1938 by M. Szydlowski and M. Planiol to develop blowers, compressors, and turbines, and its first task was the large-scale production of turbo-compressors for Hispano-Suiza piston engines.

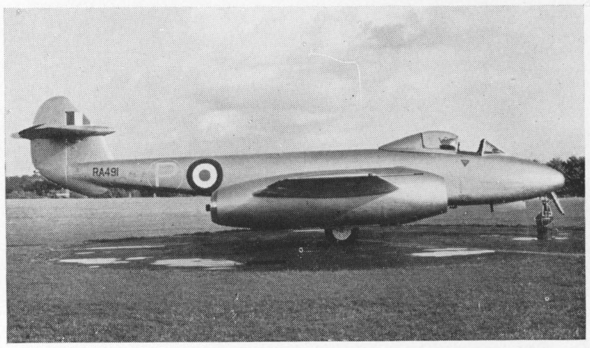
In 1941 design began of a small gas turbine which would be suitable for aircraft propulsion or auxiliary power generation. No construction was possible until after the war, and the first engine was then built as the TR.011 Piméné turbojet. The first flight was made on July 14, 1949, in a Fouga Cyclone. Five of these engines were then ordered by the French Air Ministry and the fifth of these completed a 150-hr. type test in December 1949, being the first French turbojet so to do. The Piméné developed 242 lb. s.t.

The Turboméca Company has since that time developed an extensive range of small gas turbines for all types of application. The engines in the various ranges all make use of common design features and even, to some extent, interchangeable parts. They are best considered in their various classes depending upon application.

Later turbojets, derived from the Piméné, are the Palas, of 353 lb. s.t., and the Marboré, of 660 lb. s.t.; the Marboré II has been further developed to give 880 lb. s.t. The company also built and tested a small ducted fan, the Aspin, which, with a single-stage compressor and a two-stage turbine, was originally rated at 440 lb. s.t. and later boosted to 795 lb. s.t. in the Aspin II.

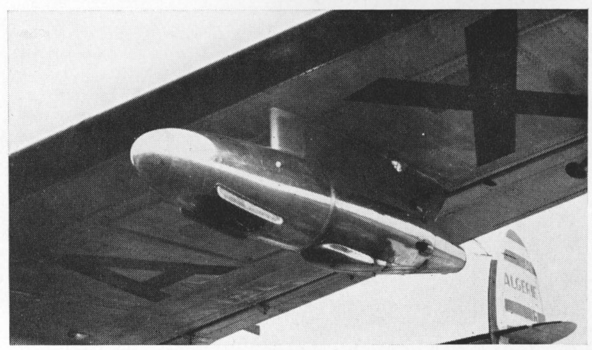


(Above) *Languedoc with Atar 101 mounted above fuselage.*

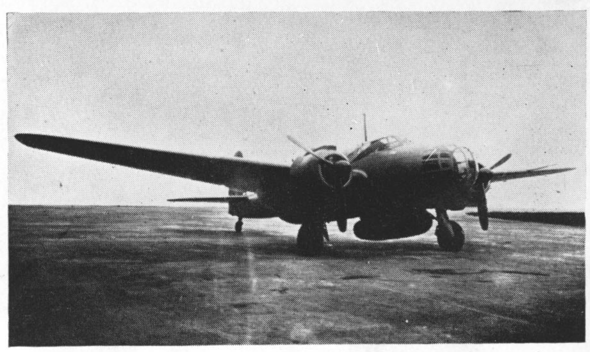


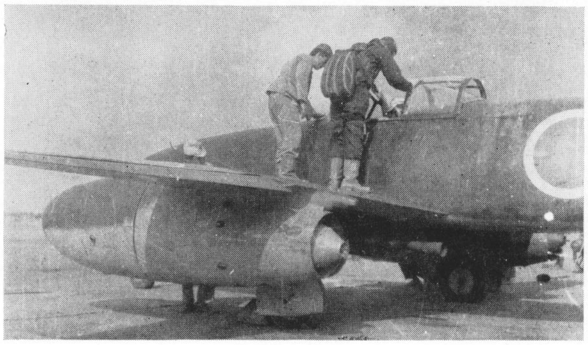
(Above) *Meteor F.4* (*RA491*) *with two Atar 101 turbojets.*

(Above) *S.O.30P* (*F–WAYD*) *with Atar 101 turbojets.*

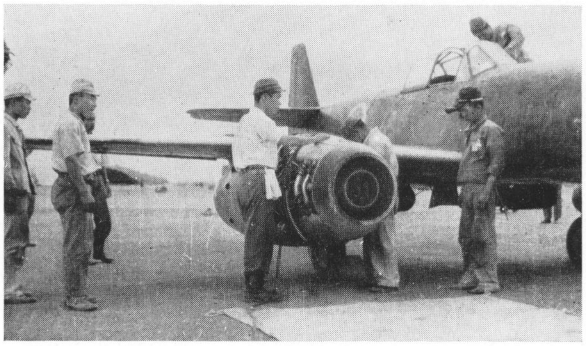


(Above) *Palas turbojet mounted under wing of S.O.30.* (Below) *Kawasaki Type 99* (*Ki–48*) *with Ne–00 turbojet underslung.*

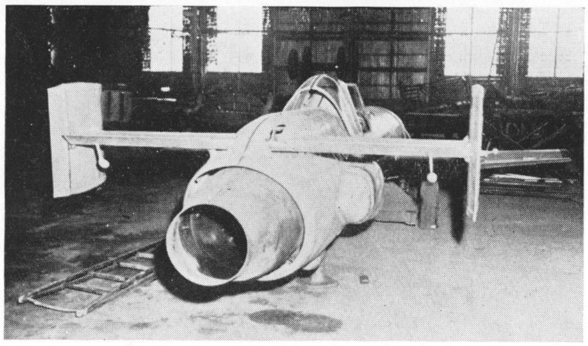




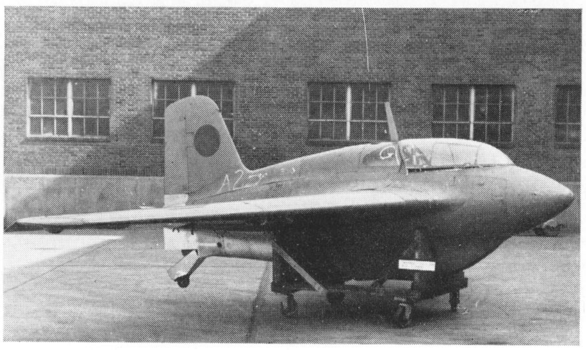
(Above and below) *The J8N1 Kikka with two Ne–20 units being prepared for first flight.*



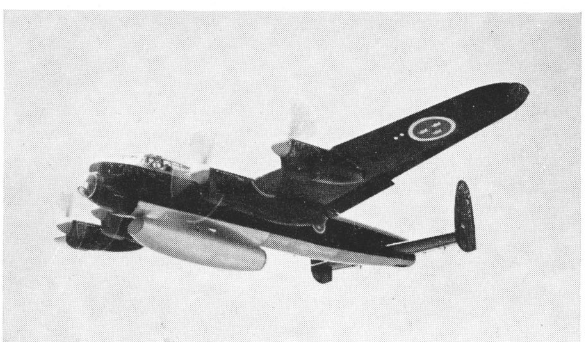
(Below) *Oka 22 with Tsu-11 turbojet in rear fuselage.*



(Below) *The J8M1 (Ki–200) Shusui with Toku (or KR 10) rocket.*



(Below) *Lancaster (80001) with STAL Dovern under fuselage.*



Shaft turbines, which have been applied in particular to helicopters, are the Artouste I of 280 s.h.p. and the Artouste II of 400 s.h.p. Consisting fundamentally of an Artouste II with the addition of a gearbox, the Marcadau is a straightforward turboprop. In the same class is the Oredon, rated at 160 s.h.p. and of primary use as an auxiliary power unit.

Two other groups are the turbo-compressors and the air generators, with helicopter applications. The Arrius I and Arrius II are shaft turbines, coupled directly to single-stage centrifugal compressors; they have maximum air outputs of 2·78 lb./sec. and 3·97 lb./sec. respectively. The first air generator was the Pimedon, with an air output of 1·0 lb./sec. The larger Palouste I has an output of 2·0 lb./sec., and the Palouste II is equipped with fully automatic starting and controlling devices.

The largest Turboméca engine announced was the Ossau, a 2,200 lb. s.t. unit on which work has not proceeded. Unlike other Turboméca engines this used a diagonal-flow compressor, and an afterburner was also being developed to boost the thrust of this engine to 2,500 lb. s.t.

ITALY

Much publicity attended the work of Signor Campini in Italy in 1940–1 but his achievement was in fact limited, and the work was along a line of development which proved to be unfruitful. This was the use of an orthodox piston engine in a duct (the fuselage) to drive a compressor (ducted fan) with a ring of fuel injectors downstream to heat the compressed air. No turbine was used, its function being performed, with less efficiency, by the piston engine.

Caproni built, to Campini designs, the N–1 (usually known as the C.C.2) which was a two-seater with a 900 h.p. Isotta-Fraschini engine, driving a three-stage ducted fan or compressor. After endless development trouble, the N–1, which first flew in August 1940, succeeded in flying from Milan to Rome on November 30, 1941. Its top speed could be increased by the use of "afterburning" in the fuselage downstream of the piston engine.

Caproni proposed a number of fighter and bomber designs using ducted fans, and also projected a modification of the Re 2005 fighter with power boosting of this type, but the Italian Air Force was not over-enthusiastic in the light of experience with the N–1, and no further jet work was done in Italy up to the end of the war.

Since 1945 Italy has not produced any original gas-turbine designs, but Fiat have now initiated production of the de Havilland Ghost 103, for French Sud-Est Aquilon (Sea Venom) production.

JAPAN

Interest in jet-propulsion engines was shown in Japan from about 1930, but as elsewhere, official support was not forthcoming until 1940 or later. In 1941 the Institute of Naval Aeronautical Technology established a special department of its Power Plant Division at Yokosuka, and this led to the construction of a Campini-type engine, the Tsu–11, in which a Hatsukaze 11 in-line piston engine drove a ducted fan. The Tsu–11 developed 441 lb. and was eventually used to power the Oka Model 22 suicide bomb as well as being used as a booster unit.

Also sponsored by the Navy was the less successful Tr–10, initially run with a centrifugal and later re-designed with an axial compressor.

The only line of development which held real promise was a joint effort on the part of various aero-engine manufacturers and the Navy. The initial outcome was the Ne–00, test flown beneath a Kawasaki Type 99 (Ki 48) bomber in the autumn of 1943. Neither this nor the later Ne–10 went into production. The Ne–12, an axial engine rated at about 700 lb. thrust, followed a year later, but development troubles were encountered.

In mid-1944 a new design, the Ne–20, was initiated, based on photographs of the B.M.W.003 supplied from Germany. Like the Ne–12, it had an eight-stage axial compressor and was scaled down from the B.M.W.003 to give 1,050 lb. s.t. The first run was in March 1945, and the Ne–20 was used to power the J8N1 Kikka, first flown on August 7, 1945.

Further projects, the 2,000-lb. Ne–130 and the 1,950-lb. Ne–230, intended to power the Ki 201 Karya, were not built.

In 1944 Japan obtained the rights from Germany to produce the Walter 109–509 rocket engine, and this went into production to power the Oka 11 suicide bomb and the Mitsubishi Ki 200 or J8M1 rocket fighter. It was designated KR 10 or Toku Mark 2.

A post-war engine, the Omiya Fuji JO–1, has recently been completed and is now undergoing bench running. It is based in design upon the Ne–20 and is intended to give 2,200 lb. s.t. initially.

A larger turbojet design, the Ji–1, is also reported under development, to produce 6,600 lb. s.t.

SWEDEN

A Swedish engineer, A. J. Lysholm, patented gas turbines of his own design as early as 1933, and in the period 1932–7 the Bofors company built and tested for him compressors of several types and sizes. In 1934, this company also built and tested a small turbojet which completed some successful bench runs, but development of which was abandoned at the end of 1935.

Layouts were prepared by Lysholm for turbojets and turboprops, such as a 1,200 h.p. turboprop of 1936, but it was some years before any complete engine for aircraft use was built to these designs, and the first appears to have been the P/15–54, built during the war by Svenska Flygmotor AB, of which company Lysholm had become chief engineer. The P/15–54 turbojet had a two-stage centrifugal compressor, an annular reverse-flow combustion chamber and a four-stage turbine. It delivered 4,000 lb. s.t.

An interesting Lysholm scheme, originated in 1936 and tested in 1942, was the use of an exhaust turbine on a piston engine. A considerable power surplus could be obtained from this unit, especially at high altitudes, and it was planned to use this either as a jet boost, or to drive an auxiliary propeller. Such a unit, with a Lysholm compressor and a six-stage reaction turbine, was built for the Swedish Air Force and tested in July and August 1942 on a P 7, behind a Pegasus 24 piston engine.

The unit weighed 220 lb. and if it had been laid out as a simple turbojet would have given about 250 lb. s.t.

Svenska Flygmotor have not continued development of original designs, but in 1946 they started production of the Goblin, for the Saab J21R and Swedish Air Force Vampires. They are now in production with the de Havilland Ghost, in two versions for the Saab J29 and the Venoms of the Royal Swedish Air Force. An afterburner has been developed by the company for the Dovern and the Ghost and is now being fitted as standard to the Saab J29F. Production is now beginning of the Rolls-Royce Avon R.A.7, which is required for the Saab A32 Lansen and the later J35.

Stal (Svenska Turbinfabriks AB Ljungstrom) began aircraft gas-turbine development immediately after the end of the war, and the first engine built, the Skuten, was run in 1948. This turbojet used an eight-stage axial compressor and single-stage turbine and gave 3,200 lb. s.t. on the bench. It was not flown.

Stal next designed in conjunction with Svenska Flygmotor, the Dovern, with a nine-stage axial compressor and single-stage turbine, and this engine has completed over 4,000 hrs. running, including over 300 hrs. in the bomb-bay of a converted Lancaster test-bed.

SWITZERLAND

The Swiss Service Technique Militaire holds a licence from de Havilland for production of the Ghost, and this work is now proceeding, with Sulzer Bros. Ltd. as the prime contractor responsible for final assembly. The engines are required initially for Venoms ordered by the Swiss Air Force.

U.S.S.R.

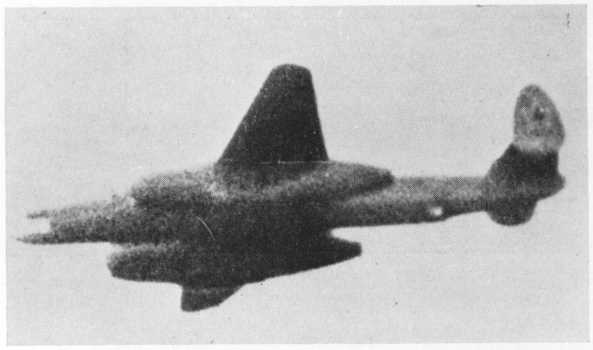
Almost the only known fact about Russian turbojets is that in the immediate post-war years development was based initially on German axial designs such as the B.M.W.003 and Jumo 004, and that a second line was based upon the centrifugal Rolls-Royce Nene and Derwent following importation of a batch into Russia in 1948.

Work on development of the German designs is thought to have been directed by A. D. Shvetsov. For convenience but without real evidence, these Russian-developed engines have become known by their original German design numbers prefixed by the letter M, as in M–003 and M–004. The Jumo 012 and 022, and the B.M.W. 018 and 028, have also been reported under development in Russia.

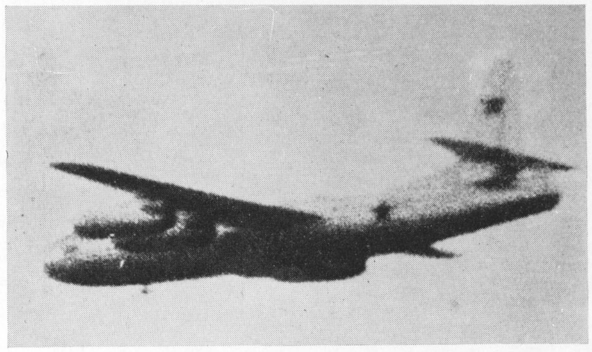
The Nene was put into production in Russia, reportedly as the M–45, development being in the charge of M. D. Chelomey. Up-rated versions are thought to have been produced as the M–45A or VK–1 of 5,500 lb. s.t. and the M-45B or VK–2 of 5,950 lb. dry or 6,800 lb. with water injection.

More advanced Russian turbojets are no doubt of axial type and the appearance and performance of current Russian aircraft suggests that the latest engines compare in thrust with types in production in the West. Nothing definite is known of turboprop development in Russia, although aircraft using this type of engine have been reported.

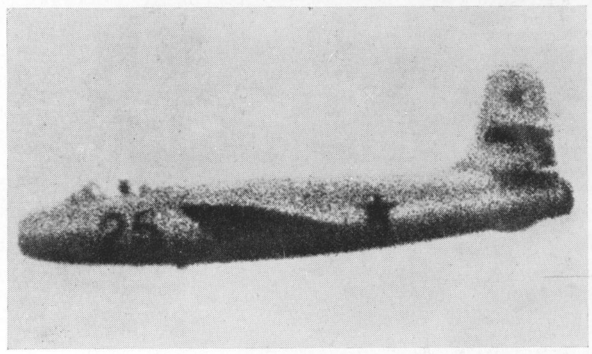
Considerable work has also been done in Russia on rocket engines for fighter boosting, and probably in more advanced aircraft for take-off and climb applications.



(Above) *The* Type 9 (*converted Tupolev TU–2*) *with axial-flow turbojets. Employed as flight test-bed during 1946–47.*



(Above) Type 10 *experimental bomber of 1947 with four axial-flow turbojets.* (Below) Type 7 *experimental fighter tested with imported Rolls-Royce Derwent centrifugal-type unit.*



DATA TABLES

On the next five pages are tables of data covering all turbojet and turboprop engines produced in the world to date, arranged alphabetically by country and manufacturer. Abbreviations used in this table are as follow: **A**, axial flow; **A.I.**, axial inducer; **Ann**, annular; **A.U.**, auxiliary power unit; **B.P.**, by-pass; **Cann**, cannular; **C**, centrifugal; **D.F.**, ducted fan; **G.P.**, gas producer; **M.F.**, mixed flow; **O.F.**, open fan; **P**, turboprop; **S**, screw; **T**, turbojet; **Tub**, tubular. A '+' sign after the power figure for a turboprop generally indicates that the shaft horsepower only is quoted, without allowance for residual thrust.

British turbojets and turboprops with M.o.S. backing are identified by experimental nomenclature comprising a letter for the manufacturer, letter group for the engine and a number for the engine variant. When any variant goes into production it receives one or more mark numbers (commencing at 100), each mark normally relating to only one specific airframe installation.

Engines for the U.S.A.F. and U.S.N. are designated J: turbojet; T: turboprop; RJ: ramjet; PJ: pulse jet and LR: liquid rocket. This designation is followed by a number for each type; numbers commence at 30, the U.S.N. using even numbers and U.S.A.F. odd numbers. Then comes a letter group for the manufacturer (not necessarily the designer) and a mark or dash number—again, even for U.S.N., odd for U.S.A.F. Manufacturers letters are: A, Allison; AC, Allis-Chalmers; AJ, Aerojet; B, Buick; BO, Boeing; C, Chevrolet; D, Chrysler; DL, De Laval; F, Ford; FF, Flader; GE, General Electric; MA, Marquardt; P, Pratt and Whitney; PM, Packard Motors; R, Fairchild (Ranger); RM, Reaction Motors; ST, Studebaker; T, Continental; TT, Taylor; W, Wright; WE, Westinghouse; WS, West Engineering.

AIRCRAFT GAS TURBINES OF THE WORLD

Company and Name of Engine	*Type of Engine*	*Type of Compressor*	*Number of Compressor Stages*	*Type of Combustion System*	*Number of Turbine Stages*	*Engine Thrust—lb. or Engine Power—e.h.p.*	*Specific Fuel Consumption lb./lb./hr. or lb./e.h.p./hr.*	*Length of Engine—in.*	*Maximum Diameter of Engine—in.*	*Engine Thrust or Power to Weight Ratio—lb./lb. or e.h.p./lb.*	*Date of Engine (approximately)*	*Remarks*
AUSTRALIA												
Commonwealth Aircraft Corp.												
Nene 2–VH	T	C	1	Tub.	1	5,000	1·09	78·0	49·5	3·10		Rolls-Royce licence for Australian Vampires
Avon R.A.7	T	A	—	—	—	7,500	0·92	110·0	42·2	3·05	1953	Rolls-Royce licence for Canberra and Sabre.
BELGIUM												
Fabrique National												
Derwent 8	T	C	1	Tub.	1	3,600	1·40	83·1	43·0	2·81		For Fokker-built Meteors.
Avon R.A. 21	T	A	—	—	—	8,000	0·92	110·0	42·2	3·05	1954	For Dutch and Belgian Hunters. R.A.23 also.
CANADA												
Avro Canada												
Chinook TR4–11	T	A	9	Tub.	1	3,000	1·00	125·1	32·0	2·32	1948	Experience engine for Orenda, 2 built.
Orenda 1	T	A	10	Tub.	1	—	—	—	—	—	1949	
Orenda 2	T	A	10	Tub.	1	6,000	—	—	—	—	1951	First Canadian engine to go into production.
Orenda 5	T	A	10	Tub.	1	6,000	1·00	132·0	42·1	2·40		Orenda is engine for CF–100.
Orenda 8	T	A	10	Tub.	1	6,000	—	—	—	—		Powers CF–100 Mk. 3.
Orenda 9	T	A	10	Tub.	1	6,500	1·00	121·3	42·0	2·41		Powers CF–100 Mk. 4.
Orenda 10	T	A	10	Tub.	1	6,500	1·00	—	—	—		Powers Sabre 5.
Orenda 11	T	A	10	Tub.	1	7,000	—	—	—	—		
Orenda 14	T	A	10	Tub.	1	7,275	1·00	—	—	—		Engine for Sabre 6
P.35 Waconda	T	A	—	—	—	15,000	—	—	—	—		Engine designed for CF–105.
Rolls-Royce of Canada												
Nene 10	T	C	1	Tub.	1	5,100	1·02	104·7	49·5	3·09		Production for Canadair T–33A–N.
FRANCE												
Hispano-Suiza												
Nene 102	T	C	1	Tub.	1	5,000	—	—	—	2·91	1946	Rolls-Royce Nene under licence.
Nene 102BR	T	C	1	Tub.	1	6,800	—	—	—	—		Experimental reheat engine.
Nene 104	T	C	1	Tub.	1	5,070	1·00	96·0	49·5	—		Powers SE Mistral.
Nene 104BR	T	C	1	Tub.	1	6,800	2·00	—	—	—		Reheat version.
Nene 105A	T	C	1	Tub.	1	5,180	1·00	96·0	49·5	3·22		Powers Indian A.F. Ouragan (Toofani).
Nene 105AR	T	C	1	Tub.	1	6,800	2·00	185·0	49·5	3·01		Reheat version.
R–300	T	C	1	Tub.	1	5,940	—	—	—	—		Redesign of Nene, abandoned.
Tay 250A	T	C	1	Tub.	—	6,280	1·06	99·6	50·0	3·15	1951	Rolls-Royce Tay under licence.
Tay 250R	T	C	1	Tub.	—	8,500	—	—	50·0	3·21		Reheat version.
R–450 Verdon 253	T	C	1	Tub.	1	7,720	1·10	103·2	50·0	3·75		Developed by Hispano-Suiza from Nene.
Verdon	T	C	1	Tub.	1	9,920	—	—	—	—		Reheat version.
Marcel-Dassault												
Viper M.D.30	T	A	7	Ann.	1	1,640	1·09	65·8	24·3	3·17	1953	Armstrong Siddeley Viper under licence.
Viper M.D.30R	T	A	7	Ann.	1	2,140	—	126·0	—	3·08	1953	Reheat version.
S.N.E.C.M.A.												
Atar 101A	T	A	7	Ann.	1	3,750	—	—	—	—		Developed from German B.M.W. 003.
Atar 101B	T	A	7	Ann.	1	4,860	1·10	—	34·9	2·59	1949	Development version.
Atar 101B–2	T	A	7	Ann.	1	5,280	—	—	—	—		Fully developed version.
Atar 101C	T	A	7	Ann.	1	6,170	1·05	145·0	34·9	2·98		First production series.
Atar 101D	T	A	7	Ann.	1	6,600	1·00	140·9	36·2	3·15		
Atar 101E	T	A	7	Ann.	1	7,300	—	145·0	34·9	3·77		Water-injection version.
Atar 101E–3	T	A	7	Ann.	1	—	—	—	—	—		
Atar 101F	T	A	7	Ann.	1	8,380	2·00	206·0	34·9	3·79		Reheat version of 101D.
Atar 101G	T	A	7	Ann.	1	9,260	—	—	—	—		Reheat version of 101E.
T.B. 1000	P	A	9	Tub.	2	2,810	—	108·9	27·5	1·97		
T.B. 1000A	P	A	9	Tub.	2	1,970	0·69	108·0	27·3	1·86		
Vulcain	T	A	7	Ann.	1	9,920	1·00	127·5	45·7	2·95	1952	Being developed to 13,230 lb.
Socema												
TGA 1	P	A	—	—	—	—	—	—	—	—	1941	Developed during German occupation.
TGA 1 Bis	P	A	15	Cann.	4	5,570	—	121·0	45·0	1·21	1945	
TGAR 1008	T	A	8	Cann.	1	4,620	1·18	111·0	40·5	—	1949	
TG 1008	T	A	—	—	—	5,500	—	—	—	—		Later version of TGAR 1008
Société Rateau												
SRA–1	B.P.	A+A	4+12	Tub.	2	2,645	1·00	80·7	44·1	1·20	1946	Gave 3,520 lb. with reheat.
SRA–101 Savoie	T	A	10	Tub.	2	7,275	0·86	150·0	43·0	3·18		Gave 8,800 lb. with water injection.
Société Turboméca												
Piméné	T	C	1	Ann.	1	240	1·10	34·6	16·1	1·98	1941	Developed from T.R.101.
Palas	T	C	1	Ann.	1	350	1·10	47·2	16·1	2·20		Engine in Miles Sparrowjet.
Aspin 1	B.P.	A+C	1+1	Ann.	2	485	—	—	—	—		Test-flown on Gemeaux IV.
Aspin 2	B.P.	A+C	1+1	Ann.	2	800	0·52	63·5	23·8	2·64		Test-flown on Gemeaux V.
Marboré 1	T	C	1	Ann.	1	660	—	—	—	—		
Marboré 2	T	C	1	Ann.	1	880	1·08	41·9	22·3	3·01		Test-flown on Gemeaux III.
Ossau	T	C	1	Ann.	1	1,765	—	—	—	—	1952	Development now abandoned.
Marcadau	P	C	1	Ann.	2	410	1·00	54·8	21·5	1·34		Propjet version of Artouste shaft turbine.
Artouste	A.U.	C	1	Ann.	2	400	0·97	41·7	21·5	1·67	—	Artouste 1 less powerful.
Palouste	A.U.	C	1	Ann.	2	—	—	41·8	19·7	—	—	Delivers 2lb. air/sec.
GERMANY												
B.M.W.												
109–003–A0	T	A	7	Ann.	1	1,760	1·47	138·0	27·5	1·07	1940	A series went into widespread production.
109–003–A1	T	A	7	Ann.	1	1,760	1·47	—	—	1·31		
109–003–A2	T	A	7	Ann.	1	1,760	1·47	—	—	1·31		
109–003–C	T	A	7	Ann.	—	1,980	1·27	—	—	—		Had Brown-Boveri compressor.
109–003–D	T	A	11	Ann.	2	2,420	1·10	124·0	27·1	1·69	1944	Redesign not built.
109–003–E1	T	A	7	Ann.	1	1,760	1·47	—	—	—		Later production series.
109–003–E2	T	A	7	Ann.	1	1,760	1·47	—	—	—		
109–003–R	T	A	8	Ann.	1	4,150	1·47	—	—	—		003–A with B.M.W. 109–718 rocket.
109–018	T	A	12	Ann.	3	7,500	1·10	158·0	50·0	1·37	1941	Not completed.
109–018R	T	A	12	Ann.	3	9,900	—	—	—	—		018 with B.M.W. 109–718 rocket.
109–028	P	A	12	Ann.	4	7,900	—	200·0	50·0	1·03	1941	Design study only.
Bramo												
109–002	D.F.	A	—	—	—	—	—	—	—	—	1942	Project for co-axial, counter-rotating engine.
Daimler-Benz												
109–007	D.F.	A+A	3+9	Tub.	1	1,340	0·81	183·0	33·0	0·69	1943	Project engine, abandoned.
109–021	P	AI+MF+A	1+1+3	Ann.	2	6,400	—	—	42·5	2·24		Taken over from Heinkel-Hirth.
Heinkel-Hirth												
HeS 1	T	C	1	Ann.	1	550	—	—	—	—	1937	Research engine only.
HeS 3B	T	AI+C	1+1	Ann.	1	1,100	—	—	36·5	1·38	1938	First German flight engine, 27/8/39.
HeS 6	T	A+C	1+1	Ann.	1	1,300	—	—	36·5	1·41	1938	Development of HeS 3.
HeS 8A 109–001	T	AI+C	1+1	Ann.	1	1,300	—	66·0	30·5	1·55	1938	Design for use in He 280.
HeS 8A–V15	T	AI+C+A	1+1+1	Ann.	1	—	—	—	—	—		
HeS 9	T	AI+MF+A	1+1+2	—	1	—	—	—	—	—		For development into turboprop.
HeS 10	B.P.	A+AI+C	1+1+1	Ann.	1	1,964	—	—	64·5	1·79	1939	Development of HeS 8.
HeS 11–V1	T	AI+MF+A	1+1+3	Ann.	2	2,460	—	—	—	—	1941	Pre-flight experimental engine.
HeS 11–V5	T	AI+MF+A	1+1+3	Ann.	1	—	—	—	—	—	1944	Featured air-cooled turbine.
HeS 11–V6	T	AI+MF+A	1+1+3	Ann.	2	2,860	1·32	—	—	—	1944	First flight series engine.
HeS 11 109–011–A0	T	AI+MF+A	1+1+3	Ann.	2	2,860	1·31	136·0	42·5	1·37	1945	First production series engine.

Company and Name of Engine	Type of Engine	Type of Compressor	Number of Compressor Stages	Type of Combustion System	Number of Turbine Stages	Engine Thrust—lb. or Engine Power—e.h.p.	Specific Fuel Consumption lb./lb./hr. or lb./e.h.p./hr.	Length of Engine—in.	Maximum Diameter of Engine—in.	Engine Thrust or Power to Weight Ratio—lb./lb. or e.h.p./lb.	Date of Engine (approximately)	Remarks
Heinkel-Hirth (contd.)												
109–021	P	AI+MF+A	1+1+3	Ann.	2	6,400	—	—	42·5	2·24		Turboprop version of 109–011.
HeS 30 109–006	T	A	5	Tub.	1	1,900	—	—	24·3	2·22	1942	Abandoned in favour of HeS 011.
HeS 40 109–006	T	A	5	—	1	—	—	—	—	—	1941	Constant volume combustion cycle.
Junkers-Jumo												
109–004–A	T	A	8	Tub.	1	1,850	1·40	150·0	30·0	0·99	1940	Flown in Me 110 in 1941.
109–004–B0	T	A	8	Tub.	1	1,850	—	150·0	31·5	1·18	1943	Reheat versions also experimented with.
109–004–B1	T	A	8	Tub.	1	1,980	1·40	—	—	1·20	1943	
109–004–D	T	A	—	Tub.	—	2,310	—	—	—	—	1945	
109–004–H	T	A	11	Tub.	2	4,000	1·20	158·0	34·0	1·60		Redesign of engine.
109–004–G	T	A	11	Tub.	—	3,750	—	—	—	—		Redesign of engine.
012	T	A	11	Tub.	2	6,000	1·20	177·0	42·0	1·37		Some parts made.
022	P	A	11	Tub.	3	6,000+	—	221·0	43·0	—		Turboprop version of 012.
Porsche												
109–005	T	—	—	—	—	1,100	—	—	—	—		Guided weapons expendable engine.
GREAT BRITAIN												
Armstrong Siddeley												
A.S.X.	T	A	14	Tub.	2	2,600	1·03	167·0	42·0	1·37	1943	Had R.A.E. Sarah compressor.
Python A.S.P.1 Mk. 1	P	A	14	Tub.	2	4,110	—	138·0	54·5	—	1944	Turboprop version of A.S.X.
Python A.S.P.2	P	A	14	Tub.	2	4,110	—	—	—	—	1948	
Python A.S.P.3 Mk. 3	P	A	14	Tub.	2	4,110	0·81	123·2	54·0	1·19	1950	Engine in Wyvern.
Mamba 1 A.S.Ma.1	P	A	10	Tub.	2	1,135	—	69·0	29·8	1·61	1945	Designed initially for Balliol.
Mamba 2 A.S.Ma.2	P	A	10	Tub.	2	850+	—	—	—	—	1946	Flew in nose of Lancaster 1947.
Mamba 3 A.S.Ma.3	P	A	10	Tub.	2	1,475	0·80	87·3	29·0	1·89	1947	
Mamba A.S.Ma.4	P	A	—	—	—	1,425+	—	—	—	—	1949	
Mamba A.S.Ma.5	P	A	—	Ann.	2	1,590	—	—	33·0	—	1951	
Mamba A.S.Ma.6	P	A	—	Ann.	2	—	—	—	—	—	1952	Test-flown in Dakota 1954.
Double Mamba A.S.M.D.1	P	A	2×10	Tub.	2×2	2,950	0·80	98·7	52·8	1·36	1947	Equal to two Mamba A.S.Ma.3
Double Mamba A.S.M.D.2	P	A	—	—	—	2,850+	—	—	—	—	1948	Equal to two Mamba A.S.Ma.4.
Double Mamba A.S.M.D.3	P	A	—	Ann.	2×2	3,190	0·71	102·3	52·8	1·40	1951	Equal to two Mamba A.S.Ma.5.
Double Mamba A.S.M.D.4	P	A	—	Ann.	2×2	—	—	—	—	—	1952	Equal to two Mamba A.S.Ma.6.
Sapphire A.S.Sa.1	T	A	13	Ann.	2	7,000	—	—	—	—	1948	Engine as taken over from Metrovick.
Sapphire A.S.Sa.2	T	A	13	Ann.	2	7,380	—	—	—	—	1949	Used in time-to-altitude record Meteor.
Sapphire A.S.Sa.3	T	A	13	Ann.	2	7,500	0·91	133·9	37·3	2·89	1949	First real Armstrong Siddeley version.
Sapphire A.S.Sa.4	T	A	13	Ann.	2	—	—	—	—	—		Development engine for Sa.7.
Sapphire A.S.Sa.5	T	A	13	Ann.	2	8,000	—	—	—	—		
Sapphire A.S.Sa.6	T	A	13	Ann.	2	8,000	0·90	134·0	37·4	3·08	1950	First production engine, reheat versions also.
Sapphire A.S.Sa.7	T	A	13	Ann.	2	10,200	0·885	127·6	37·4	—	1951	Uprated. Flown in Canberra 1954.
Adder A.S.A.1	T	A	10	Tub.	2	1,050	1·07	86·7	29·0	1·81	1948	Turbojet version of Mamba.
Viper A.S.V.1	T	A	7	Ann.	1	1,145	—	—	—	—	1949	Initial design engine.
Viper A.S.V.2	T	A	7	Ann.	1	1,575	—	—	—	—	1950	A.S.V.1, 2, 3, 4 and 6 are short-life engines.
Viper A.S.V.3	T	A	7	Ann.	1	1,640	1·09	65·4	24·7	4·37	1951	Known as Mk. 100, in production.
Viper S.A.V.4	T	A	7	Ann.	1	1,750	—	—	—	—	1952	Development of A.S.V.3.
Viper A.S.V.5	T	A	7	Ann.	1	1,640	1·09	65·4	24·7	3·38	1952	Long-life version of A.S.V.3, Mk. 101 in production.
Viper A.S.V.6	T	A	7	Ann.	1	1,900	—	—	—	—	1953	Development of A.S.V.3.
Viper A.S.V.7	T	A	7	Ann.	1	1,900	—	—	—	—	1953	Long-life version of A.S.V.6.
Viper A.S.V.7R	T	A	7	Ann.	1	2,400	—	143·4	24·7	—	1953	Fixed-nozzle reheat version.
Blackburn-Turboméca												
Palas 500	T	C	1	Ann.	1	350	1·17	25·3	17·1	2·20	1954	Redesign of Turboméca engines by
Palas 600	T	C	1	Ann.	1	390	1·20	25·3	17·1	—	1954	Blackburns. Others now available.
Marboré	T	C	1	Ann.	1	883	1·15	43·1	22·3	—	1954	Turboméca version.
Bristol Aeroplane Co.												
Theseus B.TH.3 Mk. 1	P	A+C	8+1	Tub.	3	2,140	—	105·4	49·0	0·93	1945	Had heat exchanger.
Theseus B.TH.4 Mk. 2	P	A+C	8+1	Tub.	3	2,520	—	82·6	54·0	1·14	1947	Also known as Mk. 502, had no heat exchanger.
Janus 1	P	A	—	Tub.	—	525	—	—	—	—	1946	Not developed.
Proteus B.Pt.1 Mk. 1	P	A+C	12+2	Tub.	3	3,350+	—	—	—	—	1946	
Proteus B.Pt. 1/2	P	A+C	12+2	Tub.	3	—	—	—	—	—	1947	Modified engine flown in Lincoln.
Proteus 600 B.Pt.2 Mk. 2	P	A+C	12+1	Tub.	3	2,500+	0·85	113·4	38·5	—	1948	Redesigned engine used in Princess.
Proteus 620 B.Pt.2	P	A+C	12+1	Tub.	3	2,800+	0·82	113·5	38·5	—		Modified 600.
Proteus 625 B.Pt.2	P	A+C	12+1	Tub.	—	—	—	—	—	—		Modified 620 for Britannia.
Proteus 700 B.Pt.3 Mk. 3	P	A+C	12+1	Tub.	4	3,780	0·62	100·5	39·5	1·35	1950	Second major redesign of engine.
Proteus 705 B.Pt.3	P	A+C	12+1	Tub.	4	3,780	0·62	113·0	39·5	1·35	1951	First production Proteus series.
Proteus 750 B.Pt.3	P	A+C	12+1	Tub.	4	4,150	0·62	113·0	39·5	1·42		Strengthened 705.
Proteus 755 B.Pt.3	P	A+C	12+1	Tub.	4	4,150	0·62	113·0	39·5	1·42		Second production Proteus series.
Coupled Proteus 610 B.Pt.C.1	P	—	—	—	—	5,640	0·85	179·8	83·2	—	1949	Two coupled Proteus 600 B.Pt.2 for Princess.
Coupled Proteus B.Pt.C.2	P	A+C	2×(12+1)	Tub.	2	5,600+	0·82	—	—	—		Two coupled Proteus 620.
Phoebus B.Pb.1	T	A+C	8+1	—	—	2,540	—	—	—	—	1947	Turbojet version of Proteus.
Olympus B.Ol.1	T	A+A	6+8	Cann.	2	—	—	—	—	—	1947	First British two-spool turbojet.
Olympus B.Ol.1/2	T	A+A	6+8	Cann.	2	—	—	—	—	—	1949	
Olympus B.Ol.1/2A	T	A+A	6+8	Cann.	2	9,750	0·77	124·5	40·0	2·80	1950	Engine licensed to Curtiss-Wright as J67.
Olympus B.Ol.1/2B	T	A+A	6+8	Cann.	2	9,500	—	—	—	—	1951	Development of B.Ol.1/2.
Olympus B.Ol.1/2C	T	A+A	6+8	Cann.	2	—	—	—	—	—	1951	Modified version of B.Ol.1/2B.
Olympus B.Ol.6	T	A+A	—	Cann.	2		—	—	—	—	1954	Most powerful announced British engine.
Saturn	T	A	—	—	—	3,800	—	—	—	—	1950	Parts made, but engine abandoned.
B.E.25	P	A+A	—	Cann.	3	5,800	0·55	110·3	41·5	1·88	1953	Twin-spool, constant power engine.
B.E.26 Orpheus	T	A	—	—	—	4,850	—	111·0	32·0	5·70	1953	Engine for Gnat, reheat version also.
B.E.32	P	A	—	—	—	1,000+	—	—	—	—	1954	Free turbine engine for helicopters.
Coventry Climax												
C.P.35	T	C	2	Cann.	2	250	—	48·0	18·0	—		Power Jets design taken over. Run but not flown.
De Havilland Engine Co.												
H.1 Goblin 1 D.Gn.1	T	C	1	Tub.	1	2,700	—	100·5	49·8	1·78	1942	First de Havilland turbojet.
Goblin 27 D.Gn.27	T	C	1	Tub.	1	2,700	—	100·5	49·8	1·78		First Goblin to fly, in Meteor 2.
Goblin 2 D.Gn.2	T	C	1	Tub.	1	3,100	—	100·5	49·9	1·97		Known early as Goblin 30.
Goblin 3 D.Gn.3	T	C	1	Tub.	1	3,350	1·21	100·5	49·9	2·06		In Vampire 6 and D.H.113 and 115.
Goblin 33	T	C	1	Tub.	1	3,350	—	100·5	49·9	—		Civil equivalent to Goblin 3.
Goblin 4 D.Gn.4	T	C	1	Tub.	1	3,500	—	100·5	49·9	—		Later de-rated to Goblin 3 standard.
Goblin 35	T	C	1	Tub.	1	3,500	1·19	100·5	49·9	2·15		Civil equivalent to Goblin 4.
Goblin 5 D.Gn.5	T	C	1	Tub.	1	3,600	—	—	—	—		Engine in D.H.108.
Goblin 6 D.Gn.6	T	C	1	Tub.	1	3,800	—	—	—	—		Project engine only.
H.2 Ghost D.Gt.1	T	C	1	Tub.	1	4,000	—	—	—	—	1945	Prototype engine only.
Ghost 45 D.Gt.2/2	T	C	1	Tub.	1	4,500	—	—	—	—		Engine in altitude record Vampire.
Ghost 103 D.Gt. 103	T	C	1	Tub.	1	4,850	—	—	—	—		Venom engine, known early as D.Gt.3.
Ghost 103R	T	C	1	Tub.	1	5,800	—	141·0	—	2·41		Reheat version of D.Gt.103.
Ghost 104 D.Gt.104	T	C	1	Tub.	1	4,850	—	—	—	—		Dowty spill-flow fuel system.
Ghost 48 Mk. 1	T	C	1	Tub.	1	4,850	1·21	116·0	53·0	2·29		Civil equivalent to D.Gt.103.
Ghost 48 Mk. 2	T	C	1	Tub.	1	4,850	1·21	116·0	53·0	2·29		Civil equivalent to D.Gt.104.
Ghost 50 Mk. 1	T	C	1	Tub.	1	5,050	1·15	121·0	53·0	2·29		Comet I engine.
Ghost 50 Mk. 2	T	C	1	Tub.	1	5,125	1·02	122·0	53·0	2·28		Water-methanol injection version.
Ghost 50 Mk. 3	T	C	1	Tub.	1	5,125	—	—	—	—		Water-methanol injection version.
Ghost 50 Mk. 4	T	C	1	Tub.	1	5,125	—	—	—	—		Like Mk. 3 minus coolant injection.
Ghost 55 D.Gt.4	T	C	1	Tub.	1	—	—	—	—	—		Presumably 5,500 lb. s.t. version.
Ghost 60 D.Gt.5	T	C	1	Tub.	1	—	—	—	—	—		Presumably 6,000 lb. s.t. version.
H.3	P	C	2	Tub.	3	500	—	—	—	—	1946	Run but not developed.
H.4 Gyron D.Gy.1	T	A	6	—	2	20,000	—	—	40·0	—	1953	Low pressure ratio, supersonic engine.
Gyron Junior	T	A	—	—	—	8,000	—	—	—	—		Reported in foreign sources.
Roy Fedden Ltd.												
Cotswold	P	A	11	Tub.	2	1,425	0·67	74·0	27·0	1·90	1947	Engine abandoned.

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Company and Name of Engine	Type of Engine	Type of Compressor	Number of Compressor Stages	Type of Combustion System	Number of Turbine Stages	Engine Thrust—lb. or Engine Power—e.h.p.	Specific Fuel Consumption lb./lb./hr. or lb./e.h.p./hr.	Length of Engine—in.	Maximum Diameter of Engine—in.	Engine Thrust or Power to Weight Ratio—lb./lb. or e.h.p./lb.	Date of Engine (approximately)	Remarks
Metropolitan-Vickers												
F2 Series 1	T	A	9	Ann.	2	2,400	1·19	128·0	36·0	1·18	1941	Taken over as F.1A from R.A.E. in 1940.
F2 Series 2	T	A	10	Ann.	—	2,100	1·14	—	—	—	1942	Modified and lengthened series 1.
F2 Series 3	T	A	10	Ann.	—	2,700	—	—	—	—	1943	Third production batch.
F2 Series 4	T	A	10	Ann.	1	3,750	1·05	159·0	36·5	2·00		Engine developed from F.2 series 1.
F3	D.F.	A	10	Ann.	4	4,600	—	140·0	46·0	2·00	1943	Ducted fan version of F.2 series 2.
F5	D.F.	A	10	Ann.	4	4,830	—	146·5	37·3	2·14	1945	Open fan version of F.2 series 4.
Beryl M.V.B.1	T	A	10	Ann.	1	3,250	—	—	—	—		Engine developed from F.2 series 4.
Beryl M.V.B.2	T	A	10	Ann.	1	3,500	—	—	—	—		
Beryl 1 M.V.B.2	T	A	10	Ann.	1	3,850	—	161·5	37·3	2·16	1947	
F.9 Sapphire	T	A	13	Ann.	2	7,000	—	—	—	—	1948	Taken over by Armstrong Siddeley.
D. Napier & Sons												
Nymph	P	A	—	Tub.	—	535	—	—	—	—	1946	Reached design stage only.
Naiad 1 N.Na.1	P	A	12	Tub.	2	1,590	0·73	102·0	28·0	1·45	1946	Featured a ducted airscrew spinner.
Naiad N.Na.2	P	A	—	Tub.	—	1,500+	—	—	—	—		
Naiad N.Na.3	P	A	—	Tub.	—	1,500+	—	—	—	—		
Coupled Naiad N.Na.C.1	P	A	2×12	Tub.	2×2	3,150+	—	103·0	56·5	1·24		Two coupled Naiads.
Eland N.El.1	P	A	10	Tub.	3	3,000	0·62	122·3	36·0	1·91	1952	Transport aircraft engine.
Eland N.El.3	P	A	10	Tub.	3	3,000	—	—	—	—	1954	Napier designation E.151, for Rotodyne.
Eland N.El.4	P	A	10	Tub.	3	4,000	—	123·3	36·0	—	1954	Napier designation E.153.
Oryx N.Or.1	G.P.	A+A	—	Tub.	—	750	0·68	76·0	19·3	1·52	1953	Gas producer engine for helicopters.
Oryx N.Or.2	G.P.	A+A	—	Tub.	—	—	—	—	—	—		For remotely powering airscrew turbines.
Power Jets (R. & D.)												
U(1)	T	C	1	Tub.	1	—	—	—	—	—	1937	First Whittle engine, thrust not measured.
U(2)	T	C	1	Tub.	1	480	—	—	—	—	1938	U(1) rebuilt.
U(3)	T	C	1	Tub.	1	—	—	—	—	—	1938	U(2) rebuilt.
W1	T	C	1	Tub.	1	885	1·38	—	—	1·22	1941	Flight engine for Gloster E28/39.
W1(X)	T	C	1	Tub.	1	—	—	—	—	—	1940	Early flight hops in E28/39.
W1(3)	T	C	1	Tub.	1	—	—	—	—	—		Modified W1
W1(T)	T	C	1	Tub.	1	—	—	—	—	—		Bench development model of W1.
W1A (1)	T	C	1	Tub.	1	860	—	—	—	—		Had special features of W2.
W1A (2)	T	C	1	Tub.	1	—	—	—	—	—		Modified W1A.
W2 Mk. IV	T	C	1	Tub.	1	—	—	—	—	—		Similar to W2B engine.
W2B	T	C	1	Tub.	1	1,526	—	—	—	—		Modified W2 engine.
W2B(1)	T	C	1	Tub.	1	—	—	—	—	—		Prototype engine to W2B/23.
W2B(4)	T	C	1	Tub.	1	—	—	—	—	—		Revised W2 engine.
W2B Mk. II	T	C	1	Tub.	1	1,510	—	—	—	—	1941	Modified W2B engine.
W2B/23	T	C	1	Tub.	1	1,600	—	—	—	—		Developed by Rolls-Royce as Welland.
W2/500	T	C	1	Tub.	1	1,755	—	—	—	—	1942	Improved version of W2/500.
W2/700	T	C	1	Tub.	1	2,200	1·09	—	—	—	1943	
W2/850	T	C	1	Tub.	1	2,485	1·05	—	—	2·62		
W2X	T	C	1	Tub.	1	—	—	—	—	—		"Straight through" combustion system.
W2Y	T	C	1	Tub.	1	—	—	—	—	—		"Straight through" combustion system.
Rolls-Royce												
W.R.1	T	C	1	Tub.	1	2,000	—	—	54·0	1·82	1942	First Rolls-Royce turbojet based on W2B.
Welland 1	T	C	1	Tub.	1	1,700	1·12	—	43·0	2·00		Developed from W2B/23.
B.37 Derwent I	T	C	1	Tub.	1	2,000	1·18	84·0	41·5	2·05	1943	W2B/37 as developed from W2B/26.
B.37 Derwent II	T	C	1	Tub.	1	2,200	1·08	—	—	—	1944	Only six built.
B.37 Derwent III	T	C	1	Tub.	1	2,420	—	—	—	—		Experimental boundary layer suction engine.
B.37 Derwent IV	T	C	1	Tub.	1	2,350	—	—	—	—	1945	
Derwent 5 R.D.7	T	C	1	Tub.	1	3,500	1·40	83·1	43·0	2·81	1945	Scaled-down design from Nene.
Derwent 8 R.D.7	T	C	1	Tub.	1	3,600	1·05	83·1	43·0	2·80	1950	Current production engine.
Derwent R.D.8	T	C	1	Tub.	1	4,200	—	—	—	—	1949	
Derwent R.D.9	T	C	1	Tub.	1	4,000	—	—	—	—		
Derwent R.D.10	T	C	1	Tub.	1	5,000	—	—	—	—		
Derwent R.D.11	T	C	1	Tub.	1	4,500	—	—	—	—		
R.B.39 Clyde 1 R.C.1	P	A+C	9+1	Tub.	2	3,500	0·74	121·1	46·8	1·40	1944	Compound, two-shaft engine.
Clyde 2 R.C.2	P	A+C	9+1	Tub.	2	2,500+	—	—	—	—	1946	
Clyde 3 R.C.3	P	A+C	9+1	Tub.	2	4,000+	—	—	—	—	1947	Reached 4,500 s.h.p. with coolant injection.
R.B.40	T	C	1	Tub.	1	4,200	—	—	—	—	1944	Design precursor to Nene.
R.B.41 Nene 1 R.N.1	T	C	1	Tub.	1	4,500	—	—	—	—	1944	
Nene 2 R.N.2	T	C	1	Tub.	1	5,000	—	—	—	—	1947	
Nene 3 R.N.2	T	C	1	Tub.	1	5,100	1·06	96·8	49·5	3·15		Engine for Attacker and Sea Hawk.
Nene 4 R.N.2	T	C	1	Tub.	1	5,000	—	—	—	—		Engine for P.1081.
Nene 5 R.N.2	T	C	1	Tub.	1	5,000	—	—	—	—		Engine in Tudor 8.
Nene 6 R.N.2	T	C	1	Tub.	1	5,000	—	—	—	—		Engine in Tudor 8.
Nene 10 R.N.2	T	C	1	Tub.	1	5,100	1·06	104·8	49·5	3·15		Produced in Canada.
Nene 101 R.N.2	T	C	1	Tub.	1	5,000	1·09	78·0	49·5	3·09		Similar to Nene 2.
Nene 102 R.N.2	T	C	1	Tub.	1	5,100	1·06	96·8	49·5	3·15		Similar to Nene 3.
Nene R.N.3	T	C	1	Tub.	1	5,500	—	—	—	—	1948	
R-R Griffith C.R.1	G.P.	A	3	Ann.	3	—	—	—	—	—		Had gas producer and ducted fan versions.
R.B.50 Trent 1	P	C	1	Tub.	1	1,230	—	—	—	—	1944	Turboprop version of Derwent II.
Dart 1 R.Da.1	P	C	2	Tub.	2	1,125	0·87	95·0	38·5	1·19	1945	Also known as Dart 501.
Dart 502	P	C	2	Tub.	2	1,000+	—	—	—	—	1946	Powered prototype Viscount 630.
Dart 503	P	C	2	Tub.	2	1,250+	—	—	—	—	1947	
Dart R.Da.2	P	C	2	Tub.	2	600+	—	—	—	—		
Dart 504 R.Da.3	P	C	2	Tub.	2	1,540	0·76	—	—	—		Powered prototype Viscount 700.
Dart 505 R.Da.3	P	C	2	Tub.	2	1,540	0·75	95·1	38·0	1·49		First production engine for Viscount 700.
Dart 506 R.Da.3	P	C	2	Tub.	2	1,540	0·73	95·1	38·0	1·47		Production engine for Viscount 700.
Dart R.Da.4	P	C	2	Tub.	2	1,425	—	—	—	—	1952	
Dart R.Da.5	P	C	2	Tub.	2	1,640+	—	—	—	—	1952	Scheduled for Viscount 800 series. [ship.
Dart 510 R.Da.6	P	C	2	Tub.	2	1,690+	0·71	97·0	38·0	1·53		For Viscount 700D. 507 & 511 for Friend-
Tay R.Ta.1	T	C	1	Tub.	1	6,250	—	104·0	50·0	—		Developed from Nene for Pratt & Whitney.
A.J.25 Tweed	T	A	—	—	—	2,500	—	—	—	—		Early design study for axial turbojet.
A.J.65 Avon R.A.1	T	A	12	Tub.	2	6,560	—	—	41·5	—	1945	Finalized version of Axial Jet series.
Avon R.A.2	T	A	12	Tub.	2	6,000	0·98	—	41·5	—	1947	Intermediate development engine.
Avon 100 R.A.3	T	A	12	Tub.	2	6,500	0·89	—	42·2	—	1948	First production engine known as Mk. 1.
Avon R.A.7	T	A	12	Tub.	2	7,500	0·92	110·0	42·2	3·05	1950	First major redesign stage.
Avon R.A.7R	T	A	12	Tub.	2	9,500	1·90	120·0	42·2	3·20	1952	Reheat version of R.A.7.
Avon R.A.9	T	A	12	Tub.	2	6,500	0·90	—	—	—	1952	Mk. 502 pre-production engine for Comet 2.
Avon R.A.14	T	A	14	Cann.	2	9,500	0·84	133·3	41·5	3·32	1952	Second major redesign stage.
Avon R.A.16	T	A	14	Cann.	2	9,000	0·83	—	41·5	—	1952	Rerated civil R.A.14 for Comet 3 prototype.
Avon R.A.21	T	A	12	Tub.	2	8,000	0·93	110·0	42·2	3·17	1953	Uprated R.A.7. Mks. 113, 115.
Avon R.A.22	T	A	12	Tub.	2	7,150	—	—	42·2	—	1953	Uprated R.A.3. Mk. 101.
Avon R.A.25	T	A	12	Tub.	2	7,000	0·91	102·6	42·2	2·87	1953	Mk. 503 engine for Comet 2.
Avon R.A.26	T	A	14	Cann.	2	10,000	0·86	113·3	41·5	3·58	1954	Mk. 521, civil version of R.A.28 for Comet 3.
Avon R.A.28	T	A	14	Cann.	2	10,000	0·86	113·3	41·5	3·44	1954	Probably engine in Valiant.
R.B.82 Conway R.Co.2	B.P.	A+A	—	—	—	—	—	—	—	—	1951	Twin-spool by-pass engine.
R.B.82 Conway R.Co.3	B.P.	A+A	—	—	—	—	—	—	—	—	1951	Engine for Vickers VC1000.
R.B.82 Conway R.Co.5	B.P.	A+A	—	—	—	—	—	—	—	—	1953	Latest announced Conway variant.
R.B.93 Soar R.Sr.1	T	A	—	Ann.	—	1,760	—	—	—	—	1952	Development engine.
R.B.93 Soar R.Sr.2	T	A	—	Ann.	—	1,810	1·26	62·8	15·8	6·77	1952	Vertical take-off, expendable engine.
R.B.106	T	A+A	—	—	—	15,000	—	—	—	—		Reported in foreign sources.
R.B.109	P	A+A	—	Ann.	—	4,400	—	115	40	—	1953	Twin-spool turboprop.
Rover Gas Turbines												
1S/60	A.U.	C	1	Tub.	1	60	1·40	24·5	25·5	0·57	1954	May have helicopter applications.
Rover-Power Jets												
W2B/23	T	C	1	Tub.	1	1,600	1·14	—	—	—		Rover version of Power Jets W2B.
W2B/26	T	C	1	Tub.	1	—	—	—	—	—		"Straight through" version of W2B/23.

Company and Name of Engine	Type of Engine	Type of Compressor	Number of Compressor Stages	Type of Combustion System	Number of Turbine Stages	Engine Thrust—lb. or Engine Power—e.h.p.	Specific Fuel Consumption lb./lb./hr. or lb./e.h.p./hr.	Length of Engine—in.	Maximum Diameter of Engine—in.	Engine Thrust or Power to Weight Ratio—lb./lb. or e.h.p./lb.	Date of Engine (approximately)	Remarks
Royal Aircraft Establishment												
B.10	P	A	9	Tub.	4		—	—	—	—	1940	Built by Metrovicks.
D.11	P	A	17	Ann.	8+5	2,000+	—	—	—	—	1941	Only partly manufactured.
F.1	T	A	9	Ann.	1	2,150	—	93·5	27·0	—	1939	Design for Power Jets.
F.1A	T	A	9	Ann.	2	2,690	—	—	—	—	1940	Redesign of F.1 engine.
HUNGARY												
Jendrassik	P	A	15	Cann.	10	400+	—	91·0	30·5	—	1941	Originally designed for 1,000 s.h.p.
ITALY												
Fiat												
Ghost 48 Mk. I	T	C	1	Tub.	1	4,850	1·09	130·5	53·0	2·23	1949	Ghost 103 production for Aquilon.
JAPAN												
TR–10	T	A	—	—	—	—	—	—	—	—	1941	Project for Japanese Navy.
TR–12	T	—	—	—	—	—	—	—	—	—	1942	Later development of TR–10.
NE–00	T	—	—	—	—	—	—	—	—	—	1942	Flight tested during 1943.
NE–10	T	—	—	—	—	—	—	—	—	—		Design abandoned.
NE–12	T	A	8	—	—	750	1·50	71·0	34·0	1·08	1943	
NE–20	T	A	8	Ann.	1	1,050	1·68	118·0	27·5	1·01	1944	Scaled-down B.M.W.003.
NE–130	T	—	—	—	—	2,000	—	—	—	—		Project not built.
NE–230	T	—	—	—	—	—	—	—	—	—		Project not built.
Omiya Fuji												
Jo–1	T	A	8	Tub.	1	2,205	1·11	112·0	26·8	2·23	1954	Developed from NE–20.
Ji–1	T	A	12	Tub.	2	6,600	—	—	—	—	1954	Under development.
SWEDEN												
Bofors Co.												
—	T	C	4	Tub.	7	—	—	—	—	—	1933	Design study only.
—	P	C	6	Tub.	11	—	—	—	—	—	1933	Design study only.
—	P	—	—	Tub.	—	—	—	—	—	—	1933	Design featuring heat exchange.
—	P	C	4+7	Tub.	2	800+	—	—	—	—	1934	Engine built and tested.
—	P	S	2	Ann.	10	1,200+	—	—	33·5	0·67	1936	Design study only.
S.T.A.L.												
Skuten	T	A	8	Tub.	1	3,200	—	—	—	1·86	1947	Research engine for Dovern.
Dovern IIA	T	A	9	Tub.	1	7,275	0·92	151·6	43·1	—	1949	
Dovern IIB	T	A	9	Tub.	1	7,275	0·92	151·6	43·1	2·77		No anti-icing for air intake fitted.
Dovern IIC	T	A	9	Tub.	1	10,200	—	—	—	—		Fitted with reheat.
Svenska Flygmotor												
P/15–54	T	C	2	Ann.	4	4,000	0·95	—	36·0	3·08	1944	
Ghost 50	T	C	1	Tub.	1	5,000	1·07	135·0	53·0	2·29		
Ghost	T	C	1	Tub.	1	6,000+	—	—	—	—	1953	Swedish reheat version for J–29F.
SWITZERLAND												
Service Technique Militaire												
Ghost 48 Mk. 1	T	C	1	Tub.	1	4,850	1·09	130·5	53·0	2·23	1949	Ghost 103 for Swiss Venoms.
U.S.A.												
Allison												
J33–A–6	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	2·53		J33 is derived from G.E.C. I–40.
J33–A–8	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	2·53		Similar engine to –35.
J33–A–10	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	2·53		Similar engine to –35.
J33–A–16	T	C	1	Tub.	1	5,850	1·00	99·2	50·3	—		
J33–A–16A	T	C	1	Tub.	1	6,350	1·00	99·2	50·3	3·31		Gives 7,000 lb. with water injection.
J33–A–23	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	2·53		Similar engine to –35.
J33–A–25 (400–C4)	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	2·53		Similar engine to –35.
J33–A–29	T	C	1	Tub.	1	8,200	—	—	—	—		U.S.A.F. reheat engine similar to –16.
J33–A–31	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	2·53		Similar engine to –35.
J33–A–33 (400–D9)	T	C	1	Tub.	1	4,600	—	210·6	49·3	1·82		Reheat version giving 6,000 lb.
J33–A–35 (400–C13)	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	2·53		Gives 5,400 lb. with water injection.
J33–A–37	T	C	1	Tub.	1	4,600	1·12	104·5	49·2	—		Developed for guided missiles.
J35–A–4	T	A	11	Tub.	1	5,000	—	—	—	—		Was G.E.C. TG–180.
J35–A–11	T	A	11	Tub.	1	5,000	—	—	—	—		
J35–A–15	T	A	11	Tub.	1	5,000	—	—	—	—		J35–A–4, –11, –15, –17, –17A, –19 and –21 are all similar engines to J35–A–29.
J35–A–17	T	A	11	Tub.	1	5,000	—	—	—	—		
J35–A–17A	T	A	11	Tub.	1	5,000	—	—	—	—		
J35–A–19	T	A	11	Tub.	1	5,000	—	—	—	—		
J35–A–21	T	A	11	Tub.	1	5,600	—	—	—	—		With reheat gives 6,800 lb.
J35–A–21A	T	A	11	Tub.	1	5,600	—	—	—	—		Reheat version gives 6,800 lb.
J35–A–23	T	A	16	Tub.	1	9,500	—	—	—	—		Redesign of engine which became J71.
J35–A–25	T	A	11	Tub.	1	5,300	—	146·0	37·0	—		Similar engine to –29.
J35–A–29	T	A	11	Tub.	1	5,600	1·05	146·0	37·0	2·43		
J35–A–33	T	A	11	Tub.	1	5,600	—	195·5	37·0	1·97		Reheat version of –29 giving 7,500 lb.
J35–A–33A	T	A	11	Tub.	1	5,600	—	195·5	37·0	1·97		Similar engine to –33.
J35–A–35	T	A	11	Tub.	1	5,600	—	195·5	37·0	1·97		Similar engine to –33.
J35–A–41	T	A	11	Tub.	1	5,600	—	195·5	37·0	1·97		Similar engine to –33.
J71–A–2	T	A	16	Cann.	3	—	—	—	—	—		U.S.N. engine giving 14,000 lb. with reheat.
J71–A–3	T	A	16	Cann.	3	9,700	0·80	172·0	37·0	2·37		Similar engine to –9.
J71–A–7	T	A	16	Cann.	3	9,700	—	—	—	2·21		High altitude reheat version giving 14,000 lb.
J71–A–9	T	A	16	Cann.	3	9,700	0·80	172·0	37·0	2·37	1950	J71 is development of J35–A–23.
T38–A–6	P	A	19	Tub.	4	2,925	0·63	147·0	34·0	2·12	1944	501–B7 is commercial version.
520–C–1	T	A	19	Tub.	—	1,870	0·93	—	—	—		Turbojet version of T38 for U.S.N.
T40–A–6	P	A	2×19	Tub.	2×4	5,850	—	182·0	39·0	—		Similar engine to –10.
T40–A–10	P	A	2×19	Tub.	2×4	5,850	0·63	182·0	39·0	1·95	1948	Coupled T38.
T40–A–14	P	A	2×19	Tub.	2×4	7,100	—	182·0	39·0	—		Vertical take-off engine.
T40–A–20	P	A	2×19	Tub.	2×4	5,850	—	182·0	39·0	—		Similar engine to –10.
T40–A–22	P	A	2×19	Tub.	2×4	5,850	—	182·0	39·0	—		Similar engine to –10.
T54–A–2	P	A	2×19	Tub.	2×4	7,500	—	—	—	—		Coupled T56.
T56–A–1	P	A	—	—	—	3,750	—	—	—	—		Redesigned engine based on T38.
T56–A–3	P	A	—	—	—	3,750	—	—	—	—		
Boeing Airplane Co.												
500	T	C	1	Tub.	1	210	—	29·0	22·0	—		Not flown.
T50–BO–1 (502–8B)	P	C	1	Tub.	2	224	1·25	46·8	27·3	—		
T50–BO–2 (502–2F)	P	C	1	Tub.	2	175	—	—	—	0·76		
T50 (502–10B)	P	C	1	Tub.	2	270	1·02	42·8	22·7	1·10		Increased air mass flow over –2F.
Chrysler Engineering Corp.												
T36	P	A	17	—	2	1,000+	—	—	—	—		Had heat exchanger, cancelled 1949.
Continental Motors												
J69–T–3	T	C	1	Ann.	1	883	1·08	54·0	22·3	3·28	1952	Experiment version of Turboméca Marboré.
J69–T–7	T	C	1	Ann.	1	920	1·09	54·0	22·2	3·45	1953	
J69–T–9	T	C	1	Ann.	1	920	1·09	54·4	22·3	3·45	1953	
J69–T–11	T	C	1	Ann.	1	920	1·09	54·4	22·3	3·45		J69–T–7, –9, –11, –13 and –15 are similar engines for different installations.
J69–T–13	T	C	1	Ann.	1	920	1·09	54·4	22·3	3·45		
J69–T–15	T	C	1	Ann.	1	920	1·09	54·4	22·3	3·45		
J69–T–19	T	C	1	Ann.	1	1,000	—	61·5	—	3·33	1954	In production for U.S.A.F.
T51–T–1(210–1)	P	C	1	Ann.	2	290	1·00	54·3	23·2	1·09	1953	Turboprop version of Turboméca Artouste 1.
T51–T–3	P	C	1	Ann.	2	400+	—	—	—	—		Turboprop version of Turboméca Artouste 2.
Fairchild Engine Division												
J44–R–1	T	M.F.	1	Ann.	1	1,000	1·65	72·0	22·0	3·33	1951	Expendable, guided-missile engine.
J44–R–2	T	M.F.	1	Ann.	1	1,000	1·65	72·0	22·0	3·33		

Company and Name of Engine	Type of Engine	Type of Compressor	Number of Compressor Stages	Type of Combustion System	Number of Turbine Stages	Engine Thrust—lb. or Engine Power—e.h.p.	Specific Fuel Consumption lb./lb./hr. or lb./e.h.p./hr.	Length of Engine—in.	Maximum Diameter of Engine—in.	Engine Thrust or Power to Weight Ratio—lb./lb. or e.h.p./lb.	Date of Engine (approximately)	Remarks
Fairchild Engine Division (contd.)												
J44–R–12	T	M.F.	1	Ann.	1	1,000	1·65	72·0	22·0	3·33		
J44–R–20	T	M.F.	1	Ann.	1	1,000	1·65	72·0	22·0	3·33		
Fladder												
J55–FF–1 (Type 124–Lieutenant)	T	A	1	Ann.	1	1,100	1·60	79·0	15·7	3·67		Guided-missile engine with supersonic compressor.
XT33	P	A	—	Tub.	—	7,500+	—	—	—	—		Discontinued.
General Electric Corp.												
I	T	C	1	Tub.	1	—	—	—	—	—	1942	W.1 redesign by G.E.C.
I–A	T	C	1	Tub.	1	—	—	—	—	—	1942	All I series were based on Power Jets W2B.
I–A2	T	C	1	Tub.	1	1,300	—	—	—	—		
I–11	T	C	1	Tub.	1	1,100	—	—	—	—		
I–14	T	C	1	Tub.	1	1,400	—	—	—	—	1943	Based on Power Jets W2/500.
J31 (I–16)	T	C	1	Tub.	1	1,600	1·23	72·0	41·5	1·88	1943	Taken over by Allisons.
I–18	T	C	1	Tub.	1	1,800	—	—	—	—	1944	
I–20	T	C	1	Tub.	1	2,000	—	—	—	—		
J33 (I–40)	T	C	1	Tub.	1	4,000	1·19	103·0	48·0	2·20	1944	Taken over by Allisons.
J35 (TG–180)	T	A	11	Tub.	1	4,000	—	—	—	—		Taken over by Allisons.
J47–GE–2	T	A	12	Tub.	1	6,000	0·90	154·0	39·5	2·40		U.S.N. engine similar to –27.
J47–GE–11	T	A	12	Tub.	1	5,200	1·03	144·0	36·8	2·08		Similar engine to –15.
J47–GE–13	T	A	12	Tub.	1	5,200	1·03	144·0	36·8	2·08		Similar engine to –15.
J47–GE–15 (7E–TG190–C)	T	A	12	Tub.	1	5,200	1·03	144·0	36·8	2·08		Gives 6,000 lb. with water injection.
J47–GE–17 (7E–TG190–D)	T	A	12	Tub.	1	5,400	—	226·0	36·8	1·69		Reheat version giving 7,500 lb.
J47–GE–19	T	A	12	Tub.	1	5,200	1·03	144·0	36·8	2·08		Similar engine to –15.
J47–GE–21	T	A	12	Tub.	1	—	—	—	36·8	—		Complete redesign which became J73.
J47–GE–25 (7E–TG190–E)	T	A	12	Tub.	1	6,000	1·00	144·0	39·5	2·27		Gives 7,200 lb. with water injection.
J47–PM–25	T	A	12	Tub.	1	6,000	1·00	144·0	39·5	2·27		Built by Packard Motor Car Co.
J47–ST–25	T	A	12	Tub.	1	6,000	1·00	144·0	39·5	2·27		Built by Studebaker Corporation.
J47–GE–27	T	A	12	Tub.	1	6,100	0·90	154·0	39·5	2·40		Gives 6,900 lb. with water injection.
J53–1–A	T	A	13	Ann.	2	17,500	0·86	—	44·0	2·69	1949	Should give 23,750 lb. with reheat.
J73–GE–1	T	A	12	Cann.	2	9,000	0·90	200·0	36·8	2·50		Redesign of J47–GE–21.
J73–GE–3	T	A	12	Cann.	2	9,300	0·90	200·0	36·8	2·50		Similar engine to –1.
J73–GE–5	T	A	12	Cann.	2	9,000	—	—	—	—		Gives 12,000 lb. with reheat.
J77	T	A	—	—	—	—	—	—	—	—		High-thrust engine.
J79 (X–24A)	T	A	17	—	—	15,000+	—	—	—	—		All-steel supersonic engine.
X–25	T	A	—	—	—	12,000	—	—	—	—		Light-weight fighter engine.
T31 (TG–100)	P	A	14	Tub.	1	2,480	—	114·6	35·1	1·25	1943	Original design by G.E.C. steam turbine division.
TG110	P	—	—	—	—	—	—	—	—	—		Project engine only.
TG120	P	—	—	—	—	—	—	—	—	—		Was to have been coupled TG–110.
T37 Turbodyne	P	A	14	—	2	10,230	—	—	—	—		Was Northrop-Hendy Turbodyne.
XT58	P	A	—	Ann.	2	800+	—	—	—	—		U.S.N. free turbine helicopter engine.
Jharl												
6,000XA	T	A	8]	Ann.	4	—	—	144·0	40·0	—		Not proceeded with.
Lockheed												
XJ37 (L–1000)	T	A	[—	Ann.	—	5,500	—	—	—	—	1944	Transferred to Menasco.
Lycoming												
T53	P	—	—	—	—	—	—	—	—	—		
Menasco Manufacturing Co.												
XJ37	T	A	—	Ann.	—	5,500	—	—	—	—	1945	Taken over by Wright Aeronautical.
Northrop-Hendy												
XT37–1 Turbodyne	P	A	18	Tub.	4	3,800	—	—	—	—	1944	Started by Northrop in 1943.
XT37–2 Turbodyne	P	A	—	—	—	10,000	—	—	—	—	1950	Purchased by G.E.C.
Pratt & Whitney												
J42–P–2 (JT–6)	T	C	1	Tub.	1	5,000	—	—	—	—		Rolls-Royce Nene built under licence.
J42–P–4	T	C	1	Tub.	1	5,000	—	—	—	—		
J42–P–6	T	C	1	Tub.	1	5,000	1·12	103·0	49·5	2·90	1948	
J48–P–4 (JT–7)	T	C	1	Tub.	1	—	—	—	—	—		Rolls-Royce Tay developed under licence.
J48–P–5	T	C	1	Tub.	1	8,300	2·20	226·0	50·0	3·97		Reheat version.
J48–P–6	T	C	1	Tub.	1	6,250	1·00	106·7	50·0	3·13		Gives 7,000 lb. with water injection.
J48–P–6A	T	C	1	Tub.	1	6,250	1·00	106·7	50·0	3·13		Has modified fuel system.
J48–P–8	T	C	1	Tub.	1	7,250	1·00	110·0	50·0	3·30		Gives 8,500 lb. with water injection.
J57–P–1 (JT–3)	T	A+A	8+8	Cann.	3	8,700	1·00	110·0	50·0	—		First original P. & W. design.
J57–P–2	T	A+A	8+8	Cann.	3	9,700	1·00	110·0	50·0	—		U.S.N. engine similar to –3.
J57–P–3	T	A+A	8+8	Cann.	3	9,700	0·80	160·0	40·0	2·38		Gives 14,500 lb. with reheat.
J57–P–4	T	A+A	8+8	Cann.	3	9,700	0·80	160·0	40·0	2·38		U.S.N. engine similar to –3.
J57–P–5	T	A+A	8+8	Cann.	3	9,700	0·80	160·0	40·0	2·38		Similar engine to –3.
J57–P–7	T	A+A	8+8	Cann.	3	14,250	—	—	—	2·50		Reheat version.
J57–F–7	T	A+A	8+8	Cann.	3	14,250	—	—	—	—		Similar to P–7, built by Fords.
JT–3L	T	A+A	8+8	Cann.	3	9,500	—	—	40·0	—		Commercial version of J57–P–3.
J75	T	A+A	—	—	—	15,000	—	—	—	—		Should give 21,000 lb. with reheat.
YT34–P–1 (PT–2)	P	A	13	Ann.	3	5,700	0·66	157·4	34·0	2·23		U.S.A.F. engine similar to P–2.
YT34–P–2	P	A	13	Ann.	3	5,700	0·66	157·4	34·0	2·23	1946	U.S.N. engine.
YT34–P–12	P	A	13	Ann.	3	—	—	—	—	—		Slightly modified engine.
YT34–P–12A	P	A	13	Ann.	3	—	—	—	—	—		Has true annular combustion chamber.
PT2F–1	P	A	13	Ann.	3	5,600	—	—	—	—		Civil version of T34.
T48	P	—	—	—	—	9,860	—	—	—	—		Believed to be under development.
T52	P	A	—	—	—	8,500	—	—	—	—		Abandoned 1954
Westinghouse Electric Corp.												
J30 (19A)	T	A	6	Ann.	1	1,360	—	—	—	—	1943	Original Westinghouse design.
J30–WE–20 (19XB)	T	A	10	Ann.	1	1,600	1·28	104·5	25·8	1·94	1944	Power plant developed from 19A.
J32 (X9·5B)	T	A	6	Ann.	1	275	1·70	55·2	10·5	1·93		Developed from X9·5A.
J34–WE–11	T	A	11	Ann.	2	4,200	—	—	—	—		Has short reheat tail pipe.
J34–WE–15	T	A	11	Ann.	2	4,200	—	—	—	—		Has short reheat tail pipe.
J34–WE–17	T	A	11	Ann.	2	4,200	2·50	200·0	24·0	2·90		Reheat version similar to –42.
J34–WE–22 (24C–4B)	T	A	11	Ann.	2	3,000	—	—	—	—		Similar engine to –36.
J34–WE–30 (24C–4C)	T	A	11	Ann.	2	3,200	—	—	—	—		
J34–WE–32	T	A	11	Ann.	2	4,200	—	220·0	24·0	2·80		Reheat version similar to –42.
J34–WE–34 (24C–4D)	T	A	11	Ann.	2	3,250	1·00	122·0	24·0	2·64		
J34–WE–36 (24C–4E)	T	A	11	Ann.	2	3,400	1·00	111·4	24·0	2·82		
J34–WE–42	T	A	11	Ann.	2	4,200	2·50	200·0	24·0	2·90		Reheat version.
J40–WE–6	T	A	10	Ann.	2	7,500	—	—	40·0	—		Has "Y" intake.
J40–WE–8	T	A	10	Ann.	2	11,600	—	—	40·0	—		Reheat version.
J40–WE–22	T	A	10	Ann.	2	11,600	2·20	300·0	40·0	—		Reheat version similar to –8.
J46–WE–4 (24C–10)	T	A	11	Ann.	2	4,500	—	—	38·0	—		Redesign of J34.
J46–WE–8 (24C–10D)	T	A	11	Ann.	2	4,500	—	182·0	—	2·25		Reheat version giving 6,000 lb.
Wright Aeronautical												
J59	T	A+A	—	—	—	12,000	0·88	—	42·0	3·00	1949	Presumably abandoned.
J61	T	A	12	—	3	11,000	0·91	—	42·0	—	1949	Abandoned in 1949.
J65–W–1	T	A	13	Ann.	2	7,200	—	—	—	2·77		Armstrong Siddeley Sapphire under licence.
J65–W–2	T	A	13	Ann.	2	7,200	0·91	146·0	37·5	—		
J65–W–3	T	A	13	Ann.	2	7,200	0·91	146·0	37·5	2·77		Standard version in production.
J65–W–4	T	A	13	Ann.	2	7,800	—	—	—	—		
J65–W–5	T	A	13	Ann.	2	7,200	0·91	146·0	37·5	—		Has gas turbine starter.
J65–W–6	T	A	13	Ann.	2	10,500	—	—	—	—		U.S.N. reheat engine.
J65–W–7	T	A	13	Ann.	2	7,500	—	—	—	—		
J65–B–3	T	A	13	Ann.	2	7,200	0·91	—	—	—		Built by Buick, similar to W–3.
J67	T	A+A	6+8	Cann.	2	15,000	0·80	—	—	—		Bristol Olympus under licence.
XT35–W–1 Typhoon	P	A	18	Tub.	—	5,500+	—	—	—	—	1944	First Wright gas-turbine.
T47	P	A+A	6+8	Cann.	—	16,000	—	—	—	2·71		Turboprop version of J67.
T49 (TP–51)	P	A	13	Ann.	—	10,000	0·68	—	—	2·36		Turboprop version of J65.

JET HELICOPTERS

All basic forms of jet propulsion—i.e. the turboprop and turbojet gas turbine, the pulse jet, the ramjet and the rocket—have now been successfully applied to rotary-winged aircraft, and there is little doubt that the future of helicopters is very closely linked with jet propulsion, and especially the gas turbine.

Applications of these various types of power plant have produced three basic propulsive systems for helicopters, with a number of variations. These systems are as follows:

1. *Shaft drive*. This is the turboprop application, in which the turbine provides power to the rotor shaft in exactly the same way that it provides power to the propeller shaft in a conventional aeroplane.
2. *Gas drive*. The turbojet arrangement, which has several possible layouts, all serving the purpose of supplying compressed air, or gas, to the rotor tips, where it may be expelled direct or mixed with fuel and burnt.
3. *Tip drive*. This covers the pulse jet, ramjet and rocket types, in all of which the propulsive unit is mounted at the rotor tip itself. On very large helicopters of the future, turbojets might also be mounted in this way.

The following notes on the world's jet helicopters to date indicate to which of these three groups each belongs.

GERMANY

Doblhoff WNF 342 (gas drive). Friedrich Doblhoff began work on a jet helicopter in 1942, and construction was undertaken at the Weiner Neustadter Flugzeugwerke in Vienna, with official backing. Four development prototypes were built between 1942 and 1945, with the common designation WNF 342.

A conventional piston engine was used to drive a compressor which was the source of compressed air. This was mixed with fuel and delivered to each rotor tip, where it was burnt in a small combustion chamber. The engine also drove a propeller, and was intended to power the rotor only for take-offs and landings.

The fourth WNF 342, with a 135 h.p. engine driving the compressor from an Argus As 411 engine, had a weight of 1,410 lb., rotor diameter of 32·5 ft., and disc area of 840 sq. ft.

FRANCE

S.N.C.A.S.O. Ariel (gas drive). The SO 1100 Ariel I of 1949 had a Mathis G8 piston engine driving a compressor to provide air for rotor-tip burners. It was quickly followed by the modified SO 1110 Ariel II, flown on March 23, 1949, and using the same basic system. In the SO 1120 Ariel III, first flown on April 18, 1951, a Turboméca Arrius turbine is used as the source of compressed air.

The Ariel III has an empty weight of 1,500 lb., loaded weight of 2,750 lb., cruising speed of 84 m.p.h. and range of 155 miles. Rotor diameter is 35 ft. 6 in. and length 27 ft. 1 in.

S.N.C.A.S.O. Djinn (gas drive). The Djinn has a Palouste gas generator to provide gas at high pressure to the rotor tips, where it is ejected without additional burning. The two SO 1220 prototypes are single-seaters, the first flight being made on January 2, 1953. Now in limited production, the SO 1221 is a two-seat version, of which the first flight was made on December 16, 1953. Empty weight is about 750 lb., all-up weight 1,390 lb. and cruising speed 60 m.p.h.

S.N.C.A.S.O. Farfadet (gas drive). This is a convertiplane, using the rotor system of the Ariel III, with an Arrius to supply compressed air. There is also an Artouste shaft-drive turbine to power the propeller in the nose for forward cruising flight. Rotor diameter is 36 ft. 6 in., wing span 19 ft., cruising speed 150 m.p.h. First flight, with Arrius only, on June 9, 1953.

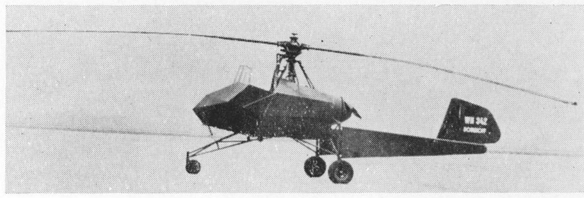
S.N.C.A.S.O./Lepere (gas drive). Now under development by S.N.C.A.S.O. this prototype is to the design of Lepere and is the first making use of co-axial ducts along the blade for "cold" compressor air and "hot" exhaust gases from the engine.

Nord 1750 (shaft drive). This prototype was flown in the summer of 1954, and is powered by a Turboméca Artouste shaft-drive turbine.

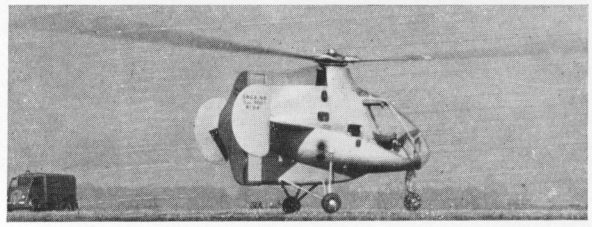
UNITED KINGDOM

Auster B.9 (tip drive). This is reported designation of a design study by the Auster company for a small A.O.P. helicopter, which would be powered by ramjets developed by the company.

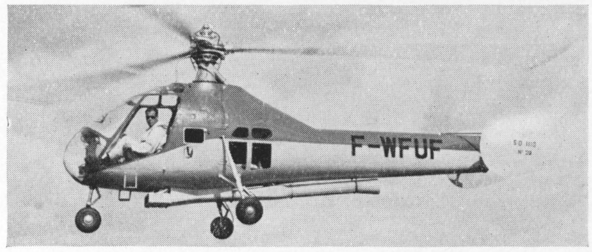
Fairey Gyrodyne (gas drive). The second prototype Gyrodyne, the first being flown in Dec. 1947, has been modified as the first British jet helicopter,



(Above) *The Doblhoff WNF 342V–4.*



(Above) *The S.O.1100 Ariel I.* (Below) *S.O.1110 Ariel II.*

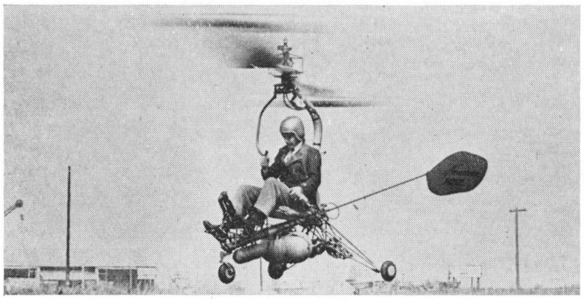


(Below) *The S.O.1120 Ariel III.*

(Below) *The S.O.1310 Farfadet.*

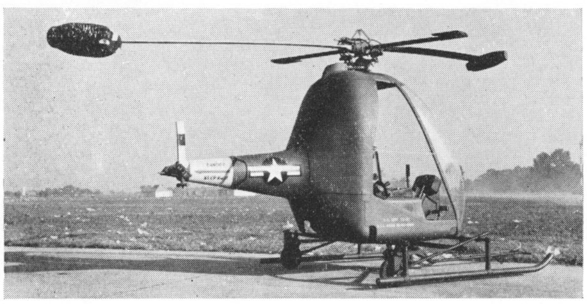
(Below) *The S.O.1220 Djinn.*

(Above) *The Fairey Gyrodyne.*

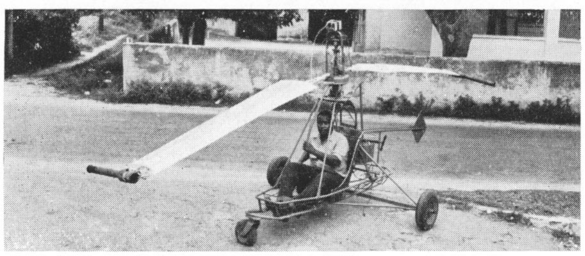


(Above) *The American Helicopters XA–6 Buck Private.*

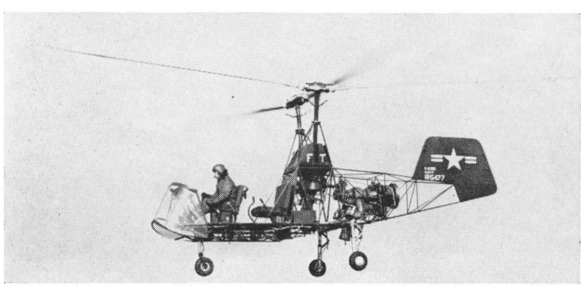
(Above) *The American Helicopters XH–26.*



(Above) *The Hiller YH–32.*



(Above) *The Jervis Baby J.* (Below) *The Kaman K–225.*



and made its first flight in the new form in January, 1954. It has an Alvis Leonides piston engine driving the compressor from a Griffon, to supply compressed air to the pressure jets at the tips of a two-blade rotor, where it is mixed with fuel and burnt. Fairey's took over the Doblhoff patents at the end of the war.

Fairey Rotodyne (gas drive). Two prototypes of this forty-passenger convertiplane are under construction. Two 2,805 s.h.p. Napier Eland N.El.3 turboprops are the source of compressed air for pressure jets on the four-blade rotor. The Elands drive conventional propellers for forward cruising flight, when the rotor "free wheels"; it is powered only for take-offs and landings. The Rotodyne has a rotor diameter of 90 ft., wing span of 47 ft. and will have a range of 290 miles at more than 150 m.p.h.

Fairey A.O.P. (gas drive). In November, 1954, it was announced that the Fairey company had an official contract for construction of an ultra-light helicopter to meet Army requirements for an A.O.P. and staff transport. The new helicopter is believed to be powered by a Blackburn Palouste engine with pressure jets at the rotor tips.

King Aircraft Corporation (tip drive). This Scottish company has been reported as having under development an ultra-light helicopter with King ramjets at the rotor tips.

Percival P.74 (gas drive). A prototype of this ten-seat helicopter is being built, with two Napier Oryx gas producers as the power plant. These engines are laid out specially for helicopter use, and provide high-pressure gas to the rotor tips, where it is ejected without further combustion. The P.74 has a loaded weight of 8,200 lb.

Percival P.86 (gas drive). This is a large forty-seat helicopter project using Napier gas turbines.

Bristol 191 (gas drive). A future development of this twin-engined twin-rotor anti-submarine helicopter is to be powered by Bristol BE 32 turboprops.

Westland W.81 (shaft drive). In 1951, Westland drew up proposals for a series of large helicopters, of which the W.81 is the smallest. Powered by an Armstrong Siddeley Double Mamba, it is envisaged as a 30-seater with an all-up weight of 18,000 lb. Rotor diameter is 75 ft. and estimated cruising speed 187 m.p.h.

Westland W.85 (tip drive). Another in the series of Westland projects, the W.85 has the unusual feature of a pair of small turbojets (such as the Armstrong Siddeley Viper) at each rotor tip. Carrying 102 passengers, it has a design all-up weight of 53,000 lb. and a rotor diameter of 104 ft.

Westland W. 90 (tip drive). This is probably the largest helicopter ever designed. Laid out to carry 450 troops, it would have an Armstrong Siddeley Sapphire in each rotor tip. All-up weight is 206,000 lb. and rotor diameter 196 ft.

U.S.A.

American Helicopters XA–5 Top Sargeant (tip drive). First research helicopter built by this company, test flown in January 1949. Powered by two American Helicopters AJ 8·75 pulse jets at the rotor tips.

American Helicopters XA–6 Buck Private (tip drive). Developed under U.S.A.F. sponsorship to continue the company's pulse jet helicopter research. Flown in February 1951.

American Helicopters XH–26 (tip drive). Designed to meet U.S.A.F. requirements for a single-seat helicopter which can be quickly collapsed and carried by air in small containers to be air-dropped. First flown on June 30, 1952. Powered by American Helicopters 6·75-in. pulse jets. Equipped weight 700 lb., maximum load 600 lb., top speed 80 m.p.h., and endurance about 1½ hrs.

American Helicopters now form the helicopter division of Fairchild Engine and Aircraft Corporation.

Bell XH–13F (shaft drive). A prototype based on the U.S.A.F. Bell Model 47 series. Powered by one Continental XT51–T–3 (Artouste) shaft-drive turbine.

Bensen Mid-Jet (tip drive). A light single-seat helicopter with ramjets at the rotor tips. Rotor diameter 15 ft., empty weight 100 lb., maximum all-up weight about 500 lb. Flown in 1954.

Capital Hoppicopter (tip drive). A single-seat ultra-light helicopter with two Naval Research Laboratory pulse jets at the rotor tips, each giving 23 lb. thrust. Empty weight 130 lb., normal gross weight 450 lb., maximum speed 90 m.p.h. Flown in 1954.

Douglas project (shaft drive). This company is developing a fifty-passenger helicopter as a DC–3 replacement type. Engines may be two Rolls-Royce RB 109 turboprop variants.

Hiller HJ–1 Hornet (tip drive). A two-seat helicopter first flown in 1950, with Hiller 8RJBC ramjets each giving 32 lb. thrust. Modified prototypes under evaluation by U.S. Army and U.S. Marines under designations YH–32 and HOE–1 respectively.

Hughes XH–17 (gas drive). An experimental heavy-lift helicopter with gas drive from two General Electric J35–GE turbojets. Compressed air

bled from engines is ducted to rotor tips, where it is burnt, with fuel, in GE33F burners. First flight on October 23, 1952. Rotor diameter over 125 ft., height over 30 ft., gross weight about 52,000 lb., payload 27,000 lb., maximum speed 80 m.p.h., range 40 miles.

Design was initiated by Kellet. Proposed XH–28 development has been abandoned.

Jervis Baby J (tip drive). A single-seat "test stand" prototype, with Jervis valved pulse jets at the rotor tips. Jervis has also developed a larger valveless pulse jet for later use.

Kaman K–225 (shaft drive). In 1951 a U.S. Navy K–225 was modified with a Boeing XT50–BO–2 shaft-drive turbine, and became the first helicopter in the world with the rotors shaft-driven by a gas-turbine engine. First flight was on December 10, 1951.

Kaman HTK–1 (shaft drive). To continue the Kaman development programme, the U.S. Navy has sponsored installation of two Boeing YT50 shaft-drive turbines in an HTK–1. First flight was made on March 26, 1954.

Kellet KH 15 (tip drive). A single-seat prototype for the U.S. Navy, with Reaction Motors XLR32–RM rocket units in the rotor tips. First flown in 1954.

McDonnell XH–20 Little Henry (tip drive). Built in 1947 under company designation J–1, and flown on May 5, 1947, as a test-bed for ramjet helicopters. Has a two-blade rotor with a Marquardt ramjet at each tip. Empty weight 280 lb., useful load 500 lb., maximum speed 50 m.p.h., rotor diameter 18 ft.

McDonnell Model 82 *XV–1* (tip drive). An experimental convertiplane developed jointly for the U.S.A.F. and U.S. Army, the XV–1 has a piston engine driving a pusher propeller and also giving power to an auxiliary compressor which provides air to the rotor tips where it is burnt in pressure jets.

McDonnell Model 78 *XHRH–1.* No details are available of this assault transport for the U.S. Marines beyond the fact that it uses gas turbine power plant.

McDonnell Model 86 *HXCH–1.* This is a large flying crane for the U.S. Marines, using gas turbine power. No other details are available until it makes its first flight.

Nagler Convert-a-Craft Model 130 (tip drive). This is a highly unconventional convertiplane, comprising an Aeronca Champion fuselage with wings replaced by a two-blade rotor. There are three small solid fuel rockets in each rotor tip to turn it for vertical take-off, after which the Model 130 flies as a gyroplane with the rotor free-wheeling.

Marquardt M–14 (tip drive). First American pulse-jet helicopter to fly, with an 8-in. diameter Marquardt pulse jet at each rotor-blade tip. Rotor diameter 29 ft.

Piasecki YH–16A (shaft drive). Second prototype of the PV–15 Transporter, to be powered by two Allison T38–A–6 engines driving the rotor shafts.

Rotor-Jets RJ–1 (tip drive). This was a small test vehicle built in 1947 to study tip power applied to helicopters. It featured a single, counter-balanced rotor blade of 8·5 ft. radius, with a ramjet at the tip.

Rotorcraft RH–1 Pinwheel (tip drive). A rocket-engined prototype developed for the U.S. Navy. Single-seat design with two-blade rotor, eventually to be "strapped on"; prototype has landing skid. First powered by Reaction Motors XLR32–RM rocket units, now has Rotorcraft-developed rockets. Flown in 1954.

Schmidt Paracopter Model 2 (tip drive). Derived from an early strap-on helicopter, successfully test flown, this casualty evacuation prototype has a Schmidt pulse jet at each blade tip. Rotor diameter 17·4 ft., height 8 ft. 7 in., empty weight 265 lb., useful load 475 lb., maximum speed 132 m.p.h. Flown in 1953.

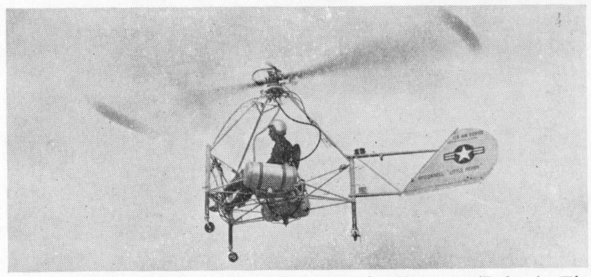
Sikorsky XH–39 (shaft drive). Prototype based on experiments with a Sikorsky S.52 powered by an Artouste engine. The Sikorsky S.59 (XH–39) has a Continental T51–T–3 above the fuselage, driving the rotor. First flight in 1954.

JAPAN

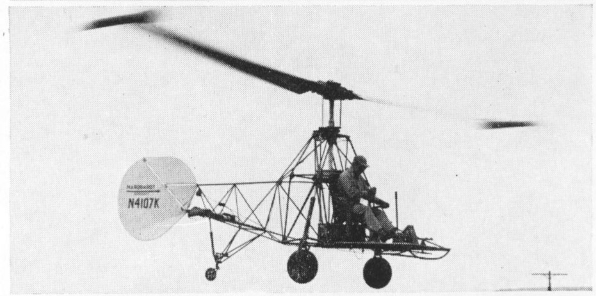
Kayaba Industrial Co. (tip drive). This company, which built Autogyros before the War, has developed a convertiplane based on a Cessna 170 lightplane and powered by a 180 h.p. Continental E–180 engine driving a propeller. This engine is also used to start the rotor, which has ramjets at the blade tips.

NETHERLANDS

SOBEH (tip drive). This is the first helicopter of Dutch origin, designed for experimental purposes. It has a small ramjet at each rotor-blade tip. The initials Sobeh come from *Stichting tot Ontwikkeling en Bouw van een Experimenteel Hefschrefuliegtuig.*



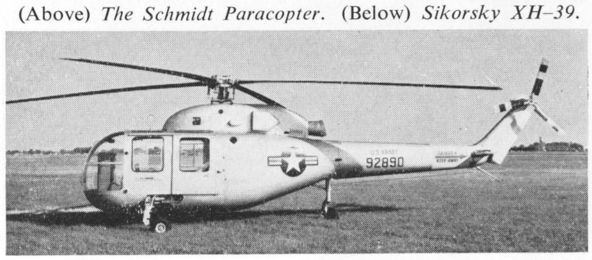
(Above) *The McDonnell XH–20 Little Henry.* (Below) *The McDonnell Model 82,* or *XV–1.*

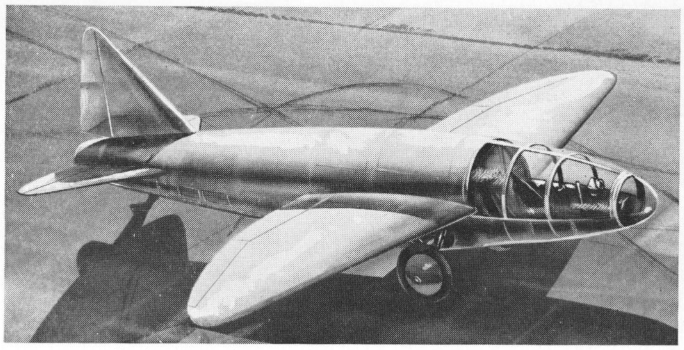


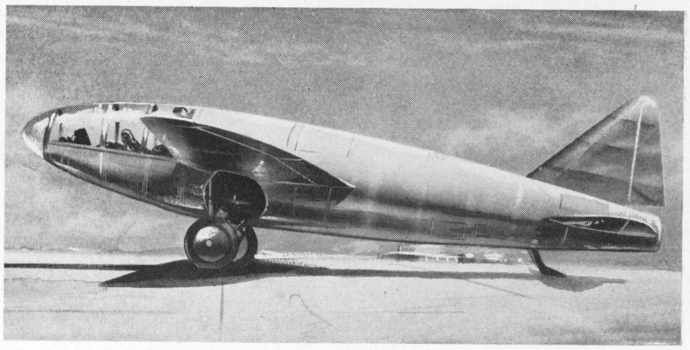
(Above) *The Marquardt M–14.*

(Above) *The Rotorcraft RH–1.*

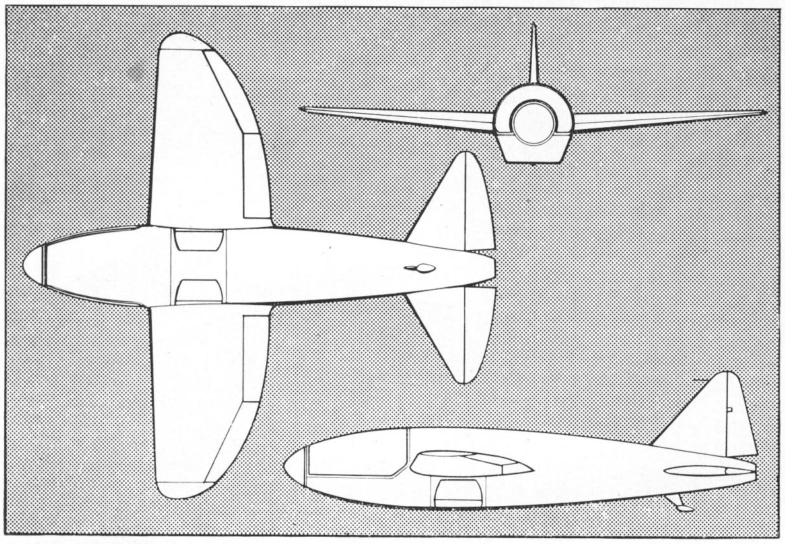
(Above) *The Schmidt Paracopter.* (Below) *Sikorsky XH–39.*







In these artist's impressions of the He 176 noteworthy features include the jettisonable cockpit capsule and the small, highly-loaded wing.

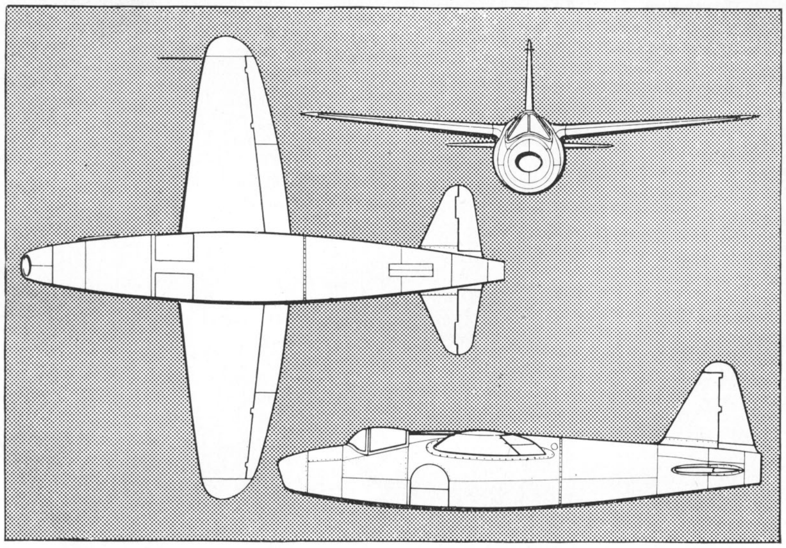


HEINKEL HE 176 (JUNE) 1939

The unique property of the liquid-fuel rocket motor is its ability to provide high thrust for short duration. Its inordinately high fuel consumption restricts its use for aircraft propulsion and, as a sole means of power, the rocket motor is acceptable only when endurance can be sacrificed to extreme speed. It is not surprising therefore that the world's first jet aircraft, the rocket-driven He 176, was designed to raise the world's air speed record above the 1,000 km./h. mark.

The design of the He 176 was commenced late in 1937 by Hans Regner of the Ernst Heinkel A.G. Apart from the propulsive unit employed, the He 176 embodied several novel features. The pilot, who sat in a semi-reclined position, was housed in a jettisonable cockpit capsule—the forerunner of the modern ejector seat—and wing loading at take-off was exceptionally high. The He 176 was extremely small, the wing span and length each being 16 ft. 5 in. and the wing area only 54 sq. ft. The maximum fuselage diameter was 2 ft. 7½ in. The Walter HWK R.I rocket motor gave 1,100 lb. thrust and its hydrogen peroxide and methanol tanks were housed in the fuselage immediately aft of the cockpit.

The rocket motor was installed early in 1939, and in June, after protracted ground trials using short bursts of power, the He 176 left the ground for the first time, flying in a straight line for 50 seconds and landing successfully. Several other flights were made, and on July 3, 1939, the He 176 was demonstrated before Adolf Hitler and Hermann Goering, but no further development was undertaken, the machine eventually being destroyed by bombing in the Berlin Air Museum.



HEINKEL HE 178 (AUGUST) 1939

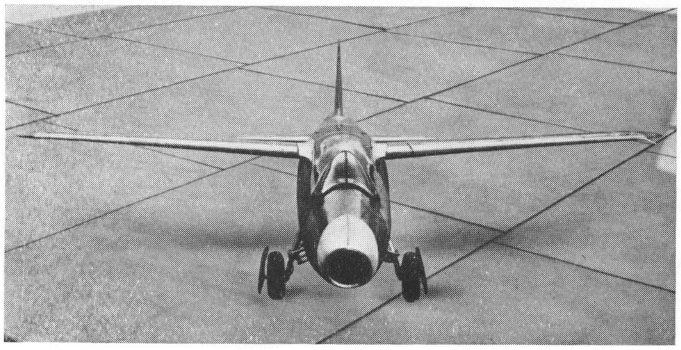
The Heinkel He 178, the world's first aircraft to be powered solely by a turbojet, was designed as a flight test-bed for the Heinkel-Hirth HeS 3B centrifugal turbojet. The layout chosen for the He 178 was surprisingly similar to that chosen for the first British jet aircraft, the Gloster E.28/39, employing a simple air intake in the nose to give full ram effect, the air then passing straight through the engine and out through a tail orifice.

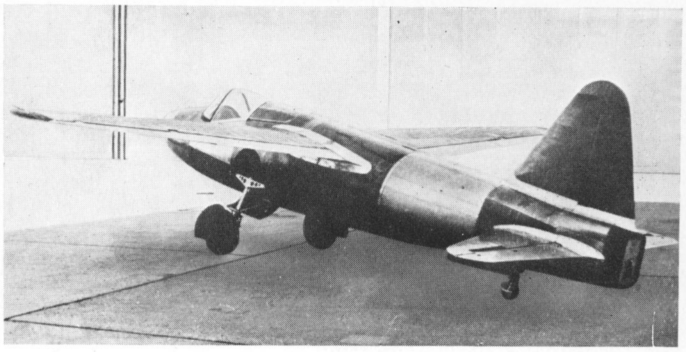
The He 178, work on which was commenced in 1938, had a shoulder-positioned wing of wooden construction and a duralumin monocoque fuselage. The HeS 3B turbojet delivered 1,100 lb. thrust and burned petrol. It was installed aft of the pilot's cockpit and the air intake bifurcated and passed on either side of the pilot who was provided with a rudimentary throttle with which to control the thrust.

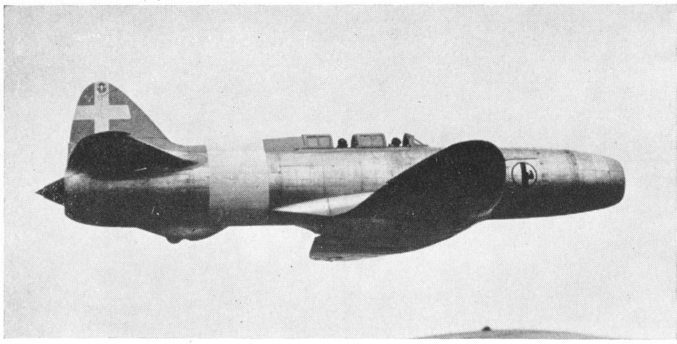
On August 24, 1939, the He 178 left the runway for the first time, flying in a straight line at an altitude of a few feet and landing successfully. On August 27 it flew its first circuits but the test pilot was forced to make an emergency landing. Several completely successful flights were made, and on November 1, 1939, the He 178 was demonstrated before officials of the German Air Ministry.

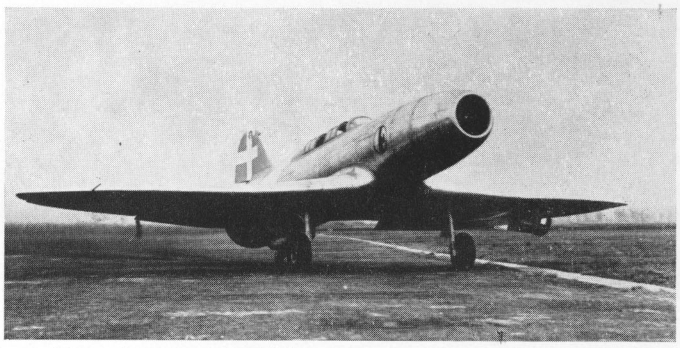
The He 178 weighed 3,439 lb. empty and 4,400 lb. loaded. The maximum speed attained during flight tests was 435m.p.h., and dimensions were as follows: Span, 26 ft. 8 in., length, 24 ft. 7 in., wing area, 85 sq. ft., wheel track, 5 ft. 11 in.

The world's first turbojet-powered aircraft, the He 178 is seen here prior to its first powered flight, on August 27, 1939.



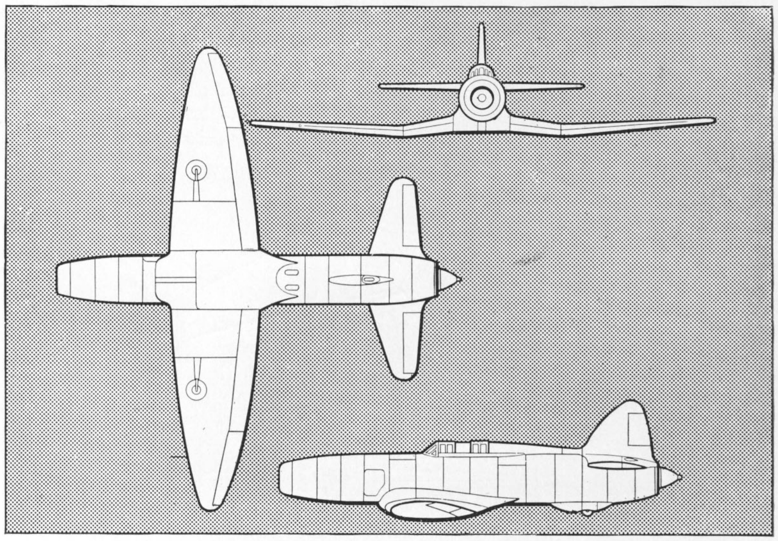






The Caproni-Campini N.1 employed a piston engine to drive a three-stage ducted fan.

CAPRONI-CAMPINI N.1 (AUGUST) 1940

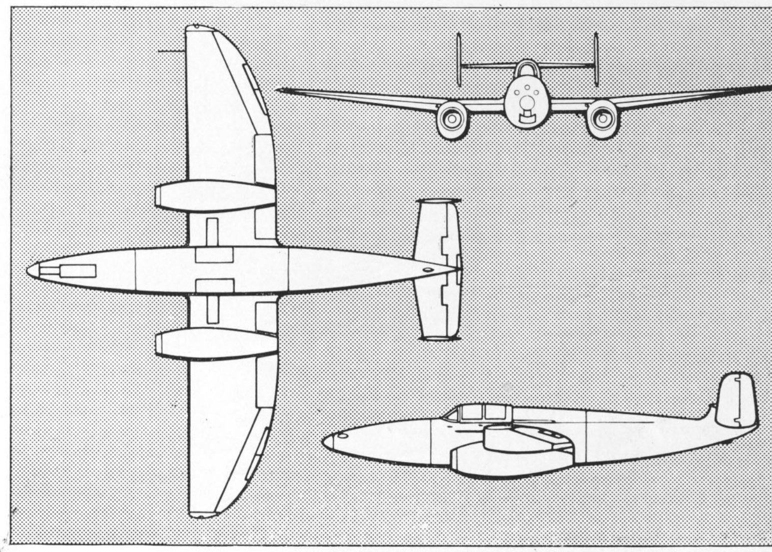


The Caproni-Campini N.1 (frequently referred to by the incorrect designation "C.C.2") was designed by Secondo Campini and built by the Societa Italiana Caproni. Flown for the first time on August 27, 1940, at the Taliedo airfield, Milan, the N.1 two-seat research aircraft employed a 900 h.p. Isotta-Fraschini piston engine to drive a three-stage ducted fan and afterburner. This system of jet propulsion was only partially successful, but a number of test flights were made. After modifications, the N.1 was flown from Taliedo airfield to the Guidonia Research Establishment, near Rome, on November 30, 1941, stopping at Pisa for refuelling, and completing the 168-mile flight at an average speed of 130 m.p.h.

The Caproni-Campini N.1 was tested for eight months at Guidonia, but unsatisfactory results led to the discontinuation of flight trials. However, Signor Campini continued the development of designs employing this system of propulsion and put forward proposals for increasing the performance of existing combat aircraft by installing a jet unit.

The N.1 was of all-metal construction. The Isotta-Fraschini engine was mounted in the main fuselage section and the blades of the ducted fan could be varied in pitch. The exhaust orifice could be varied in area by an adjustable "bullet". The wing span was 52 ft., and the length 43 ft. Empty and loaded weights were 8,024 lb. and 9,250 lb. respectively, and maximum speed was 205 m.p.h. at 9,800 ft., and 196 m.p.h. at 13,000 ft. With afterburner in use maximum speed at 9,800 ft. was increased to 233 m.p.h. Initial climb rate was 364 ft./min., and the maximum altitude attained on test was 13,000 ft.

HEINKEL HE 280V (APRIL) 1941



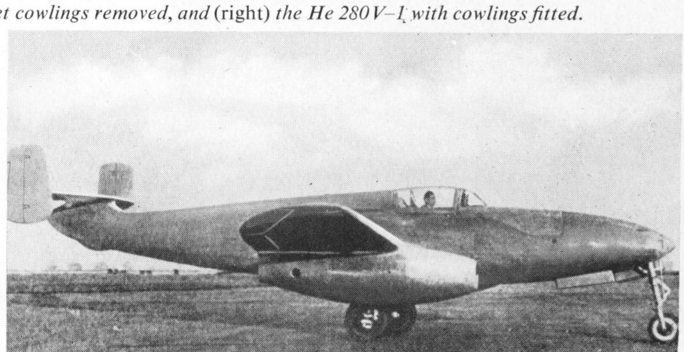
The Heinkel He 280 possesses the distinction of being both the first twin-jet aircraft *and* the first jet-propelled fighter.

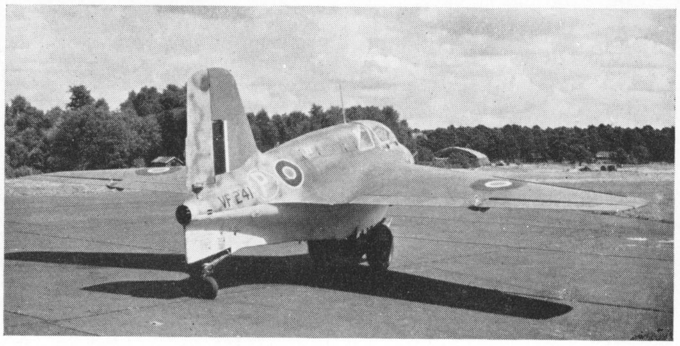
Design of the He 280 was initiated in the summer of 1939, and the airframe of the first prototype, the He 280V–1, was completed a year later. However, as the HeS 8A turbojets had not reached the flight-testing stage, the He 280V–1 was completed as a glider, with dummy jet nacelles, and in this form some twenty take-offs and landings were made. Early in 1941 two Heinkel-Hirth HeS 8A (109–001) turbojets, each giving 1,320 lb. thrust, were installed, and the He 280V–1 made its first powered flight on April 5, 1941. The method of mounting the turbojets outboard on the wing, as exemplified by the He 280, was a layout favoured for other early jet fighters (e.g. the Gloster Meteor and the Me 262).

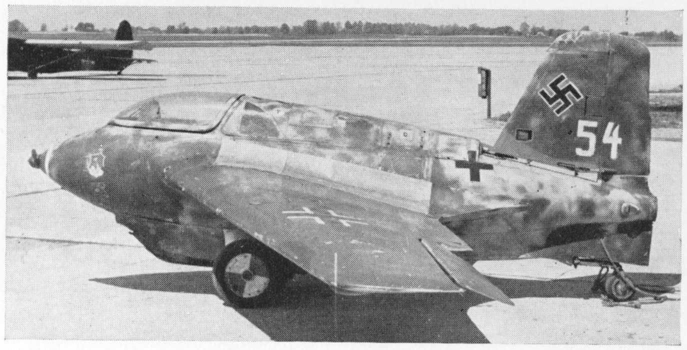
During initial trials the He 280V–1 achieved a level speed in excess of 500 m.p.h., but the HeS 8A turbojet proved to be unreliable, and by the time more suitable turbojets were available the Me 262 had proved its superiority. Eight prototypes of the He 280 were built (V–1 to V–8), but no quantity production was undertaken. Several of the later prototypes were fitted with B.M.W. 003A turbojets and were employed for various flight tests.

Estimated performance with HeS 8A turbojets included a maximum speed of 577 m.p.h. at 19,700 ft., an endurance of 46 min. and an initial climb rate of 4,920 ft./min. Loaded weight was 9,920 lb.; span, 39 ft. 5 in.; length, 34 ft. 1 in.; and wing area 231·5 sq. ft.

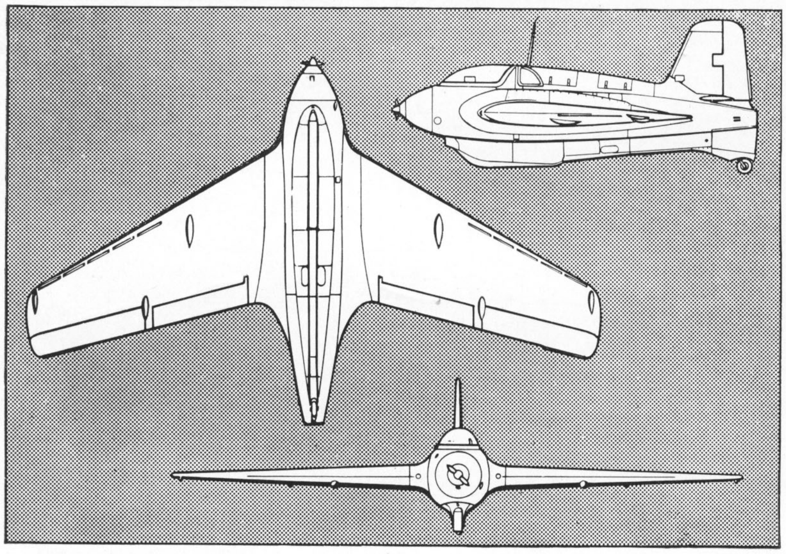
(Below, left) *The He 280V–1 taking off on its first flight with turbojet cowlings removed, and* (right) *the He 280V–1 with cowlings fitted.*







Photographs and general arrangement drawing depict the operational Me 163B–1. The Japanese version of the Me 163B is illustrated on page 30 and the Me 163A on page 13.



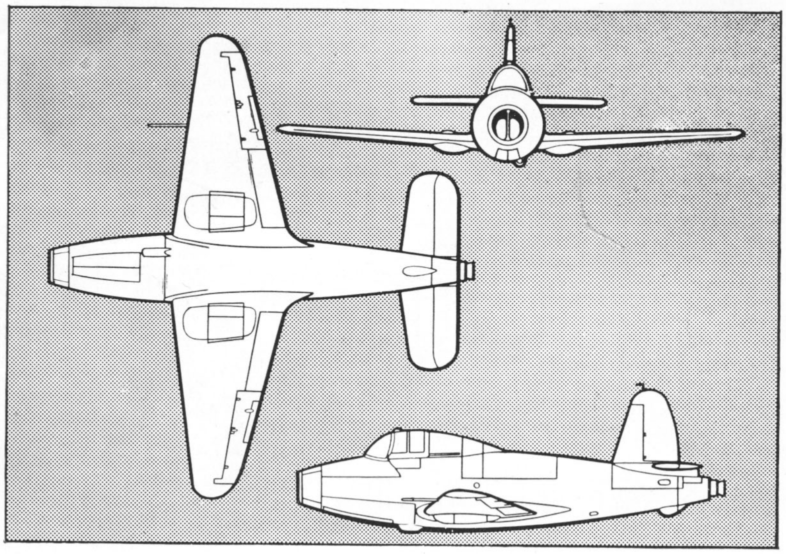
MESSERSCHMITT ME 163B–1 (APRIL) 1941

The Me 163B–1 Schwalbe (Swallow) single-seat fighter was the first successful rocket-propelled combat aircraft, and appeared in operational service late in 1944. Designed by Alexander Lippisch as the DFS 194, the Schwalbe was originally tested as a glider in 1940, and later with an 85 h.p. Pobjoy piston engine in the nose. The Me 163V–1 commenced powered flight tests in April 1941, and on May 10, 1941, test pilot Heinz Dittmar attained a level speed of 623·85 m.p.h.

The Me 163V–1 and V–2 were powered by the Walter HWK R.II–203 rocket motor, which was intended for the first production model, the Me 163A, but owing to its dangerous characteristics was replaced by the HWK 109–509A, which ran at higher temperatures. The version of the Schwalbe employing the later motor was designated Me 163B, and the twelve Me 163As were completed as training gliders.

The Me 163B–1 had a jettisonable two-wheel undercarriage for take-off and a retractable metal skid for landing. Its bi-fuel rocket motor had a thrust range of 440–3,750 lb. thrust at all altitudes, and furnished a top speed of 550 m.p.h. between 10,000 ft. and 30,000 ft. Empty and loaded weights were 4,200 lb. and 9,500 lb. respectively. Dimensions were: span, 30 ft. 7 in.; length, 18 ft. 8 in.; wing area, 211 sq. ft.

A total of 364 Me 163B fighters was built, and a modified version, the J8M1 or Ki–200 Shusui (Rush of Wind), was built by Mitsubishi in Japan. The Me 163V–6, prototype for the Me 163C, tested in 1944, utilised the HWK 109–509C rocket with auxiliary cruising chamber which increased powered duration to 12 min. and total thrust to 4,400 lb.



GLOSTER G.40 (E.28/39) (MAY) 1941

The Gloster G.40 was the first British jet-propelled aircraft to fly. Design was initiated in September 1939 to meet the requirements of Air Ministry specification E.28/39, and the aircraft was primarily intended to flight test the Power Jets W.1 turbojet. Two prototypes were built, the first initially having the unairworthy W.1X turbojet for preliminary taxi-ing trials. This was replaced by the W.1 of 850 lb. thrust for flight testing, and the G.40 first flew on May 15, 1941. After 10 hours' flying with the W.1—during which an altitude of 25,000 ft. and a speed of 300 m.p.h. were recorded—this unit was replaced by the 860 lb. thrust W.1A for further trials, and later by the Power Jets W.2/500 of 1,700 lb. thrust.

Meanwhile, a second G.40 had been completed, flying for the first time on March 1, 1943, powered by the 1,220 lb. thrust Rover W.2B, which was succeeded by the 1,400 lb. thrust Rolls-Royce W.2B/23 and, finally, a 1,526 lb. thrust W.2B. With the latter turbojet the second G.40 achieved 466 m.p.h.

The G.40 was of all-metal construction, with a nose orifice for the turbojet, the airflow being divided to pass each side of the pilot's cockpit and being ejected through an efflux duct in the tail. Weights and performance varied with the type of turbojet installed, but with the W.1A unit maximum speed attained was 338 m.p.h. and loaded weight was 3,700 lb. With the W.2B loaded weight was 3,900 lb., which, with the W.2/500, was increased to 4,180 lb. Dimensions were: span, 29 ft.; length, 25 ft. 2 in.; height, 9 ft. 3 in. The first G.40 reposes in the Science Museum, South Kensington, London.

The first Gloster G.40, W4041/G without auxiliary fins (below, left), *and* (right) *with additional fins fitted in 1943.*

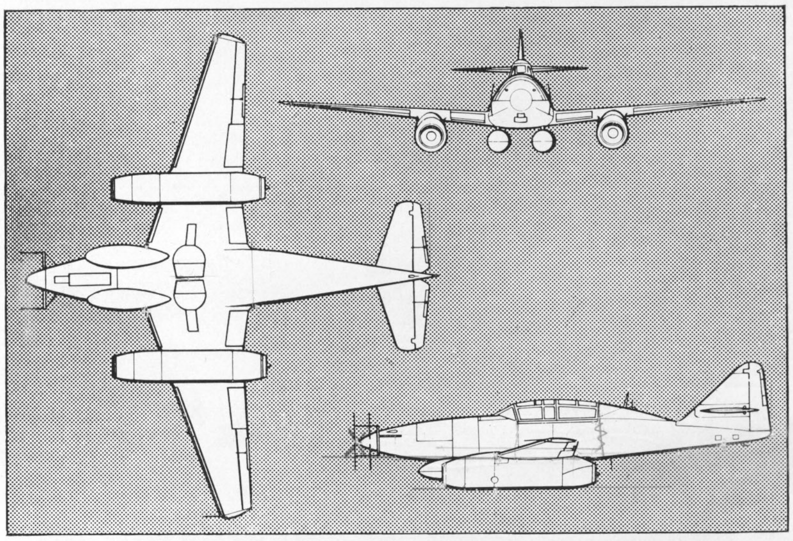
(Above, left) *A standard Me 262A–2, and* (right) *an Me 262A modified as a prototype for Me 262E. Drawing depicts Me 262B–2.*

MESSERSCHMITT ME 262 (JULY) 1942

The Me 262 Stürmvogel (Stormbird) was the first operational jet combat aircraft. The first prototype, the Me 262V–1, flew initially with a Jumo 211 piston engine in the summer of 1941. The second machine, the Me 262V–2, flew for the first time on July 18, 1942, powered by two 1,850 lb. thrust Junkers Jumo 004A turbojets.

The initial production model, the Me 262A–1 interceptor, powered by two 1,980 lb. thrust Jumo 004B units, had only been produced in small numbers when changes in operational policy led to its conversion as a fighter-bomber. These carried two 250-kg. bombs, as did the next production model, the Me 262A–2. Various other versions were tested, including the Me 262B–1 (*Interzepter I*) with two B.M.W.003R units (each comprising a standard 1,760 lb. thrust B.M.W.003A turbojet and a B.M.W.718 bi-fuel rocket augmenting thrust by 2,700 lb. for 3 min.), and the Me 262B–2 two-seat night-fighter with nose radar, three examples of which were completed. Four modified Me 262As were fitted with a 50-mm. BK 5 cannon in the nose as prototypes for the projected Me 262E series, and the final version tested was the Me 262C–1 (*Interzepter II*), which was powered by two 2,200 lb. thrust Jumo 004C turbojets and had a Walter H.W.K.109–509A rocket motor of 3,750 lb. thrust in the rear fuselage. A total of 1,294 Me 262s was built.

The Me 262A–1 had a top speed of 527 m.p.h. at 23,000 ft. and a range of 590 miles. Empty and loaded weights were 9,900 lb. and 13,450 lb. respectively; and dimensions were: span, 40 ft. 11½ in.; length, 34 ft. 9½ in.; wing area, 234 sq. ft.

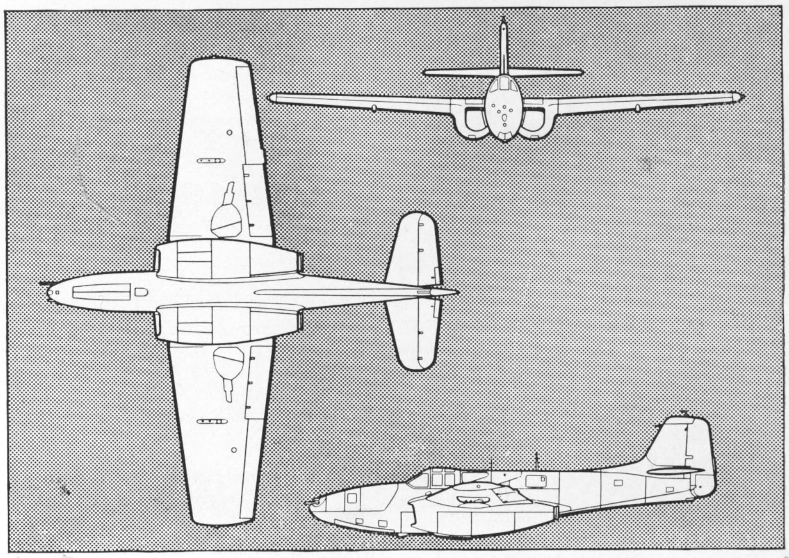


BELL P–59A AIRACOMET (OCTOBER) 1942

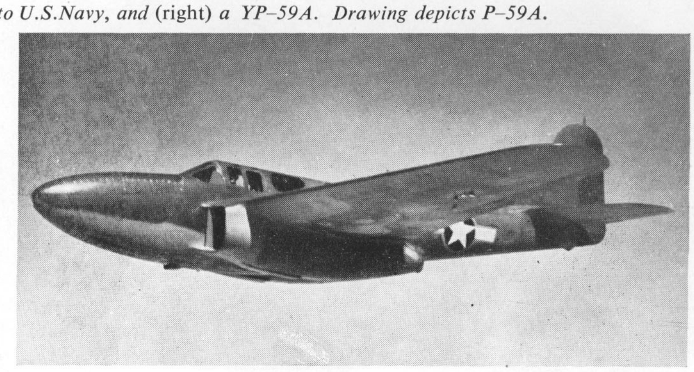
The Bell Model 27, or P–59A Airacomet, was the first turbojet-driven aircraft to be built in the U.S.A. Design work was initiated in September 1941, construction of the first of three XP–59A prototypes commencing six months later. The XP–59A flew for the first time on October 1, 1942, powered by two General Electric I–A turbojets based on British Whittle patents. These were mounted beneath the wing close to the fuselage sides. This installation proved to cause considerable aerodynamic interference, but it possessed the advantages of providing good accessibility, obviated the need for lengthy ducting and exerted no appreciable asymmetric forces in the case of the failure of one turbojet, as both units exhausted near to the fuselage centre line.

Thirteen YP–59As were built for service trials. These were generally similar to the first production model, the P–59A, which flew for the first time in August 1944. The twenty P–59A Airacomets were powered by the 2,000 lb. thrust General Electric J31–GE–3 turbojets, but performance was no higher than that of several contemporary piston-engined fighters, and the type was employed as a fighter-trainer. Top speed was 413 m.p.h. at 30,000 ft., and service ceiling was 46,200 ft. Empty and loaded weights were 7,950 lb. and 12,700 lb. respectively, and maximum range (with 240 Imp. gal. internal fuel and two 125 Imp. gal. drop tanks) was 520 miles at 289 m.p.h. at 20,000 ft. Dimensions were: span, 45 ft. 6 in.; length, 38 ft. 1½ in.; height, 12 ft.; wing area, 385·8 sq. ft.

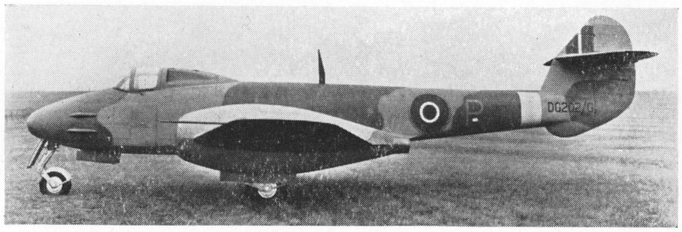
An order for eighty modified P–59Bs was cancelled on October 30, 1943, after only thirty machines had been built.



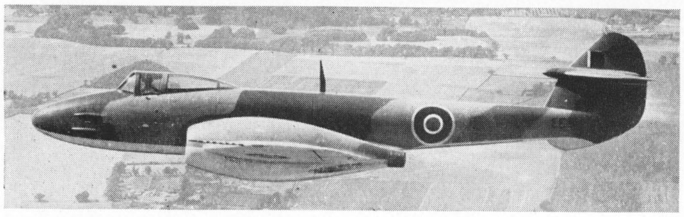
(Below, left) *One of three XF2L–1 (P–59A) Airacomets supplied to U.S.Navy, and* (right) *a YP–59A. Drawing depicts P–59A.*



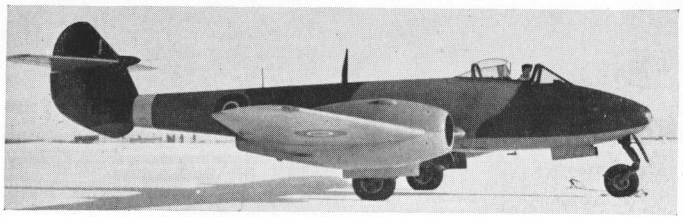
GLOSTER G.41 METEOR (MARCH) 1943



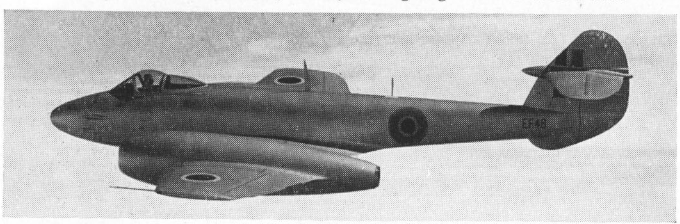
(Above) *First prototype Meteor (DG202/G) to be completed.*



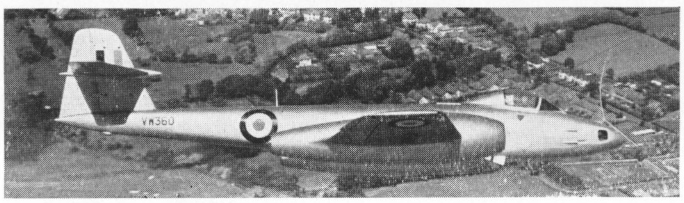
(Above) *The fifth production Meteor F.1 (EE214/G).*



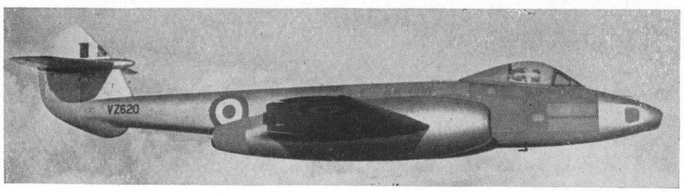
(Above) *Meteor F.3 (EE311) undergoing winterisation trials.*



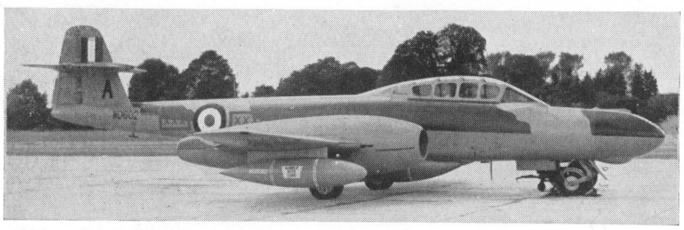
(Above) *A Meteor F.4 of the Royal Belgian Air Force.*



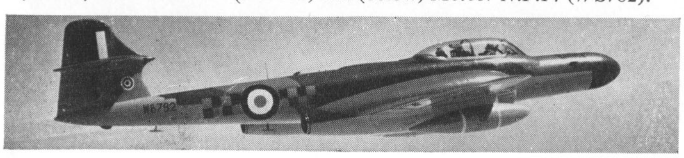
(Above) *A Meteor F.R.9 (VW360) reconnaissance fighter.*



(Above) *A Meteor P.R.10 (VZ620) high-altitude reconnaissance aircraft.*



(Above) *Meteor N.F.11 (WD602) and* (below) *Meteor N.F.14 (WS782).*



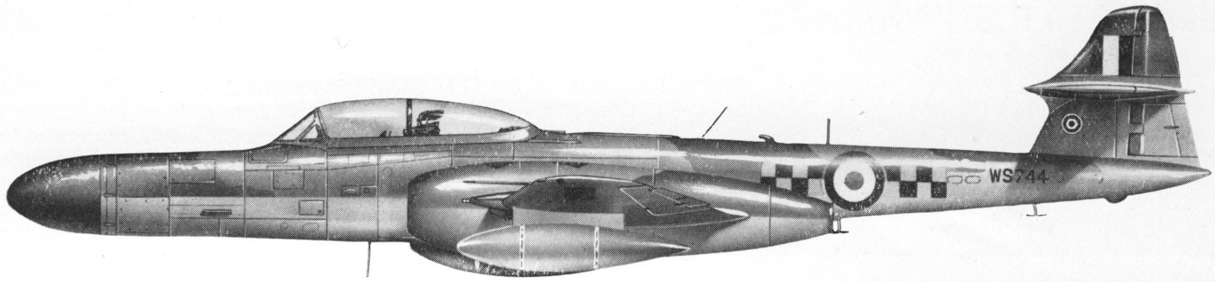
Such was the promise of jet propulsion that the British Air Ministry was giving serious consideration to the application of this new prime mover to an interceptor fighter long before flight testing had commenced of Britain's first jet aircraft, the Gloster G.40 (E.28/39). Early in 1940 Gloster Aircraft had been entrusted with the design of a single-seat interceptor to specification F.9/40. Retrospectively designated G.41, the new fighter was of conventional twin-engined layout, the use of two turbojets having been dictated by the absence of any single turbojet of sufficient thrust to provide the required performance.

Early in 1941 a contract was placed for twelve prototypes which were to accommodate the various turbojets then under development. Eventually only eight of these were completed, the first flight being made on March 5, 1943, on the power of two 1,500 lb. thrust de Havilland H–1 (Goblin) turbojets. In September 1941 twenty G.41A fighters were ordered. The name Thunderbolt was initially applied to the production model, but the use of this name for the Republic P–47 resulted in its replacement by Meteor. The Meteor F.1 was powered by two 1,700 lb. thrust Rolls-Royce Welland turbojets and attained maximum speeds of 385 m.p.h. at sea level and 410 m.p.h. at 30,000 ft. A Meteor F.1 was experimentally fitted with afterburning, which increased maximum speed to 460 m.p.h. at 1,000 ft. Initial climb rate was 2,155 ft./min., and empty and loaded weights were 8,140 lb. and 11,800 lb. respectively. An alternative production model, the G.41B Meteor F.2 with de Havilland Goblin turbojets, was not proceeded with, and production continued with the G.41C Meteor F.3. The first fifteen aircraft retained the Welland engines, but subsequent production aircraft (G.41D) had the 2,000 lb. thrust Rolls-Royce Derwent 1, which increased maximum speed to 475 m.p.h. at 30,000 ft. and initial climb rate to 4,000 ft./ min. Range was 1,340 miles at 350 m.p.h. at 30,000 ft., and more than 200 Meteors of this type were built.

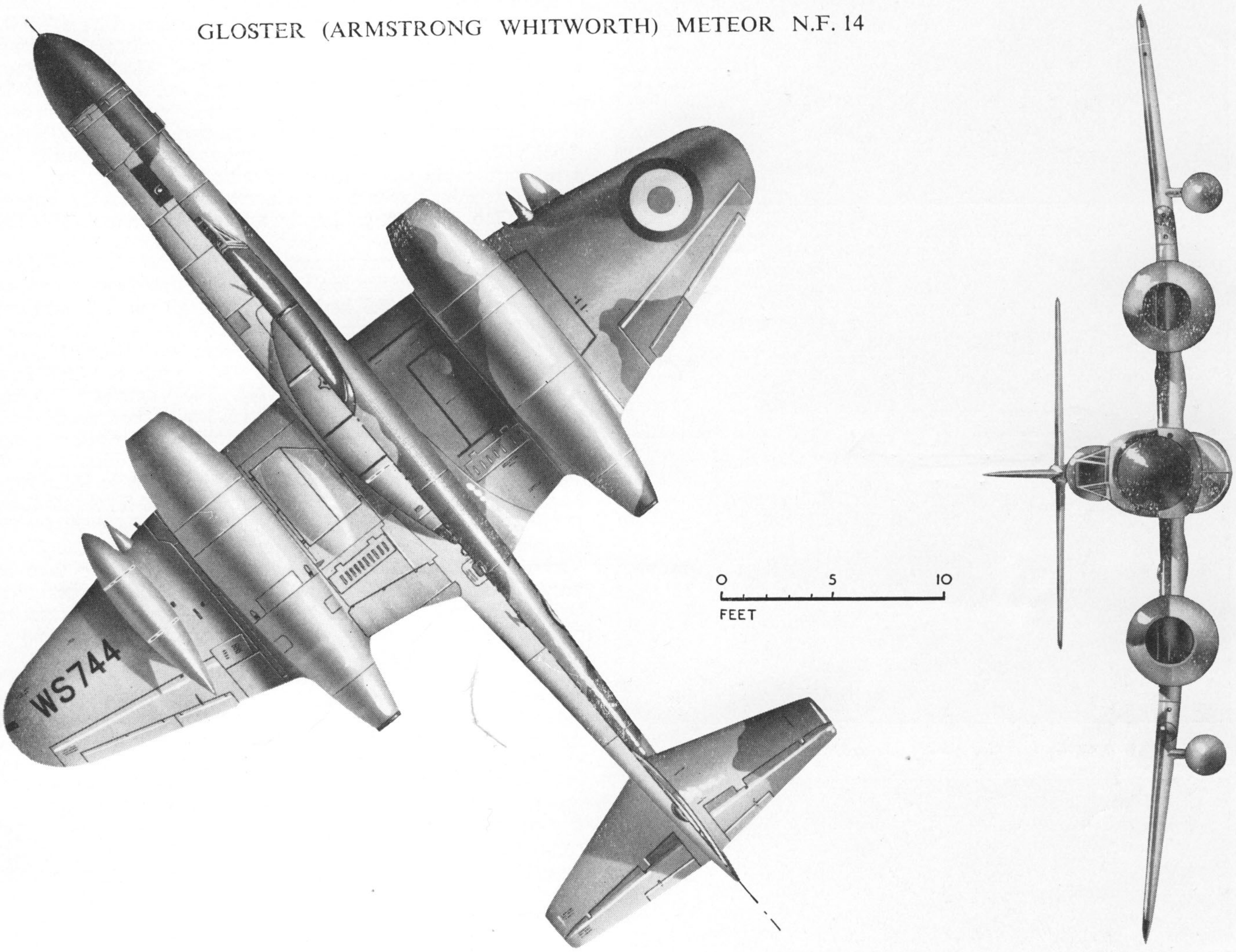
Development of the Derwent resulted in the G.41F Meteor F.4, which took advantage of the 3,500 lb. thrust available from each of its Derwent 5 engines. The Meteor F.4 had a top speed of 585 m.p.h. at sea level and an initial climb rate of 7,350 ft./min. The G.41H Meteor P.R.5 was a photo-reconnaissance version of the F.4, with vertical and oblique cameras replacing the nose armament of four 20-mm. Hispano Mk. 3 cannon, and the G.41J Meteor Mk. 6 was a projected version with a swept wing, which did not progress further than the drawing board.

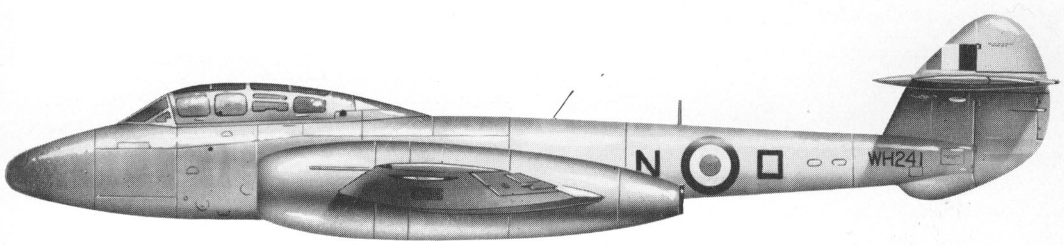
The G.43 Meteor T.7 was a two-seat trainer employing all the basic Mk. 4 components apart from the forward fuselage. The G.41K Meteor F.8 appeared in October 1948 and featured extensive revision. Powered by two 3,600 lb. thrust Derwent 8 R.D.7 turbojets, the F.8 had a new high-speed tail assembly, a redesigned cockpit and an extra 95 Imp. gal. tank which increased fuselage length by 30 in. During 1952 the air intakes for the Derwent turbojets were redesigned, their diameter being increased by 4½ in. This conferred an increase in thrust of some 200 lb. at 100 m.p.h. With the large-diameter intakes and at a loaded weight of 15,750 lb., the Meteor F.8 had a maximum speed of 592 m.p.h. at sea level and 575 m.p.h. at 20,000 ft. Initial climb rate was 7,700 ft./min., and range 562 miles at 20,000 ft. and 767 miles at 40,000 ft. The G.41L Meteor F.R.9 was a fighter-reconnaissance variant with an F.24 camera in the nose, and the G.41M Meteor P.R.10 was a high-altitude reconnaissance model with a similar nose and cockpit to the F.R.9 but the 43-ft.-span wing of the F.3 and the tail unit of the F.4.

During 1949 Sir W. G. Armstrong Whitworth Aircraft was entrusted with the development of a two-seat night-fighter variant to specification F.24/48. The first version, designated Meteor N.F.11, had a redesigned nose section to take a large A.I. scanner, and the four 20-mm. cannon armament was transferred to the wing outer panels. First flown on May 21, 1950, the Meteor N.F.11 attained a maximum speed of 579 m.p.h. at 9,842 ft. and had an initial climb rate of 5,797 ft./min. Maximum range was 920 miles at 30,000 ft., and empty and loaded weights were 13,906 lb. and 19,747 lb. respectively. The Meteor N.F.12 featured improved radar in a lengthened nose, the N.F.13 was a tropicalised version of the N.F.11, and the final production model, the Meteor N.F.14, was similar to the N.F.12 but featured a new clear-vision cockpit canopy. The length of the Meteor N.F.14 is 49 ft. 11¼ in. as compared to 48 ft. 6 in. of the Meteor N.F.11, span and height are 43 ft. and 13 ft. 10 in. respectively, and wing area is 374 sq. ft.

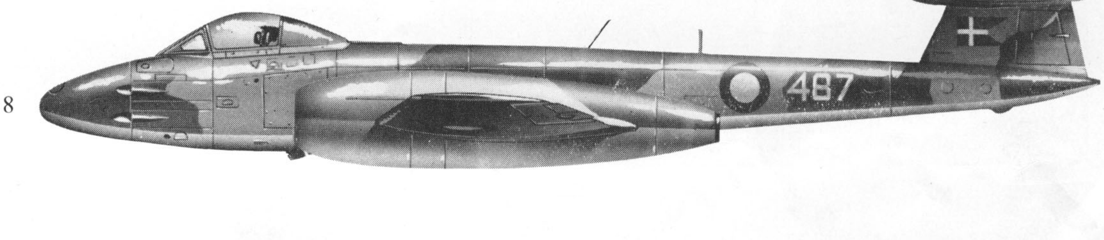


GLOSTER (ARMSTRONG WHITWORTH) METEOR N.F. 14





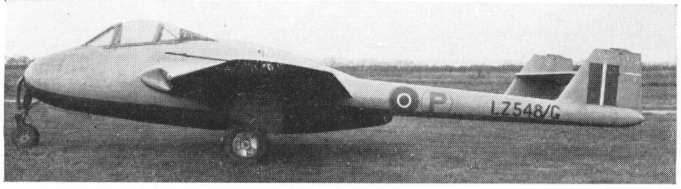
GLOSTER METEOR T. 7



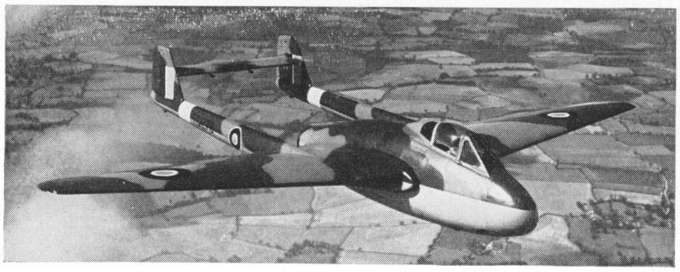
GLOSTER METEOR F. 8

DE HAVILLAND D.H.100 VAMPIRE

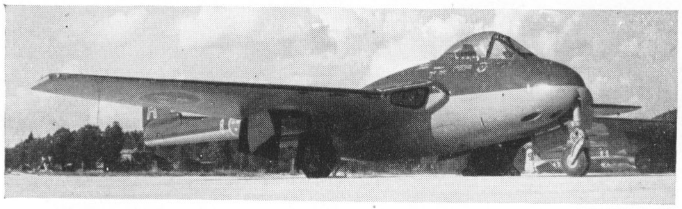
(SEPTEMBER) 1943



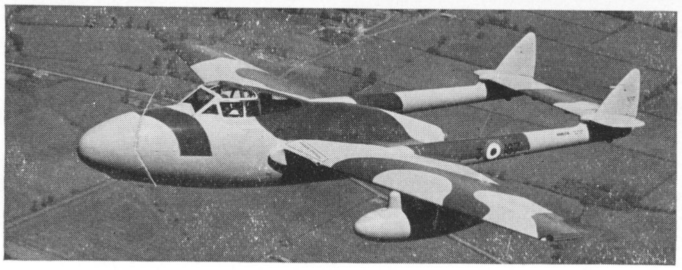
(Above) *The first Vampire prototype* (*LZ548/G*).



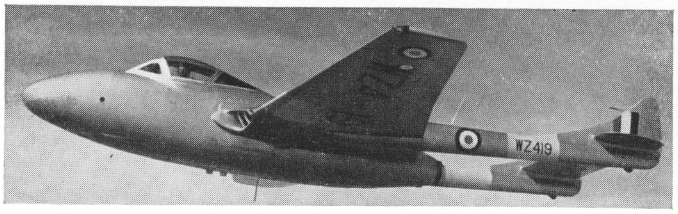
(Above) *An early production Vampire F.1* (*TG278*).



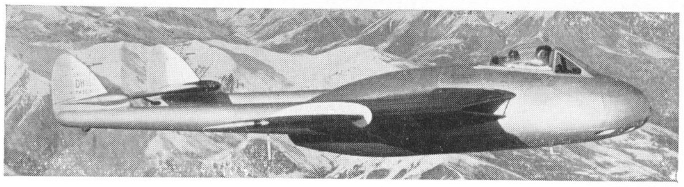
(Above) *A Vampire F.B.50 of the Swedish Air Force.*



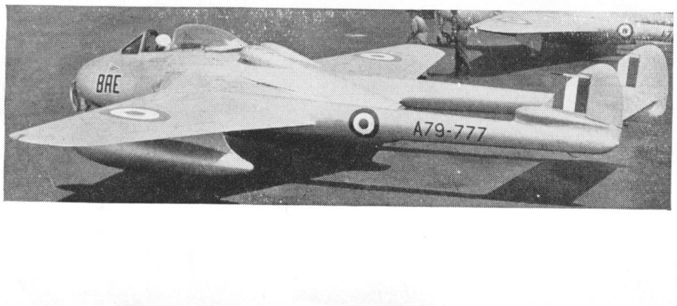
(Above) *A Vampire N.F.54 of the Italian Air Force.*



(Above) *Vampire T.11 two-seat trainer* (*WZ419*).



(Above) *Fourth production Sud-Est Mistral* (*Vampire 53*) *and* (below) *an Australian-built Vampire F.B.30.*



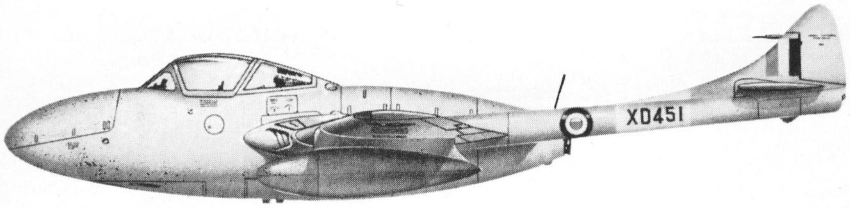
The design of the D.H.100 single-seat fighter, developed to meet specification E.6/41, evinced a novel approach to the problem of keeping intake ducting and tailpipe lengths to a minimum in order to avoid undue friction losses. All previous turbojet-driven aircraft had employed either externally mounted turbojets or a single unit with a straight-through flow arrangement. The former arrangement called for the use of two engines and the latter severely restricted internal space, and to avoid the disadvantages of both layouts the D.H.100 had the turbojet installed in the rear of a short central fuselage nacelle, drawing air from wing-root intakes and exhausting between twin tailbooms.

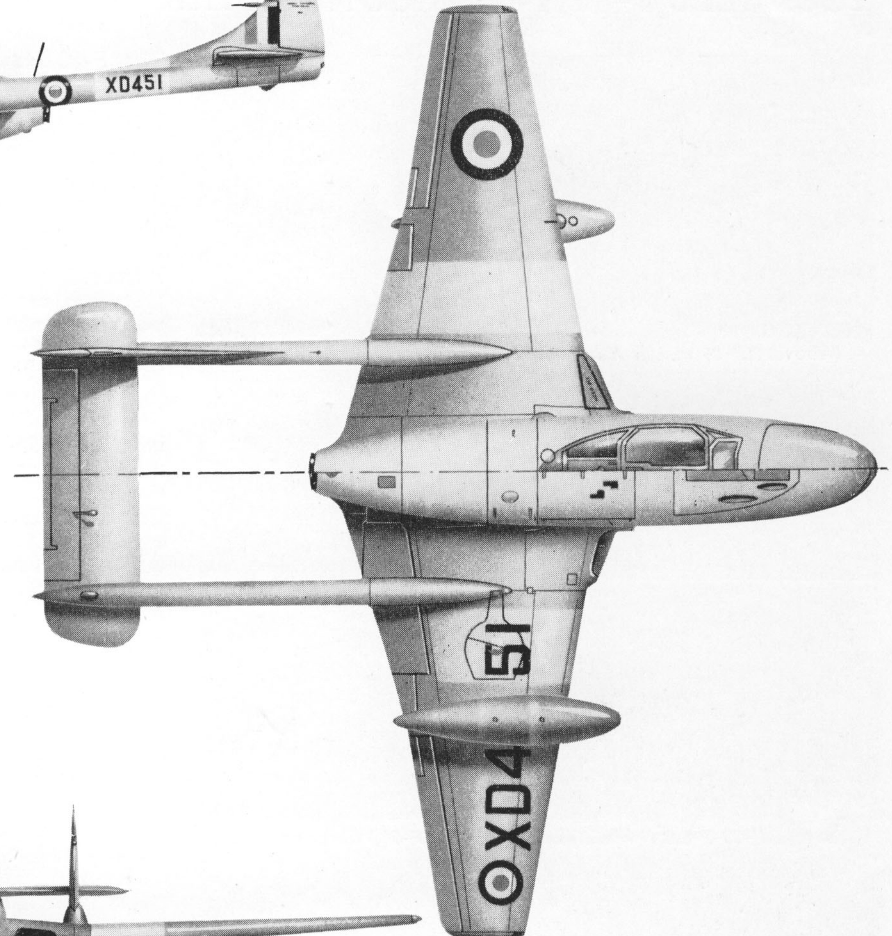
Initially known as the Spider-Crab, the first of three D.H.100 prototypes flew on September 26, 1943, powered by a 2,700 lb. thrust de Havilland Goblin D.Gn.1 turbojet and, as the Vampire F.1, was placed in production at the English Electric Company's Preston plant. The first production Vampire, which flew in April 1945, was similarly powered to the prototypes, but the forty-first and subsequent Vampire F.1s were powered by the 3,100 lb. thrust Goblin D.Gn.2. The first fifty Vampires were unpressurised, but a pressure cabin was introduced with the fifty-first production aircraft, which also featured an increase in internal fuel capacity, from 202 to 326 Imp. gal., and was fitted with jettisonable drop-tanks.

The Vampire F.1 was succeeded in production by the F.3 long-range model to specification F.3/47. First flown on November 4, 1946, the Vampire F.3 had redesigned tail surfaces and could carry either two 100 Imp. gal. jettisonable tanks or two 200 Imp. gal. tanks. Loaded weight increased from 10,480 lb. to 11,970 lb., and maximum speed and range were 540 m.p.h. at 17,500 ft. and 1,390 miles at 30,000 ft. respectively. The Vampire F.B.5 was a ground-attack fighter variant of the F.3 with reduced wing span and naval-pattern long-stroke undercarriage to allow for the higher sinking speeds on landing with the increased loaded weight. The F.B.9 was a tropicalised F.B.5. The Vampire Mk.6 export model was generally similar but had the 3,350 lb. thrust Goblin D.Gn.3 turbojet. Navalised variants employed for jet familiarisation purposes were the Sea Vampire Mks.20 and 21. The Sea Vampire F.20 had the F.B.5 wing strengthened to take both acceleration and heavier landing loads. The dive brakes and landing flaps were increased in area by 35% and 40% respectively, and an "A-type" arrester hook was housed in a fairing above the jet pipe.

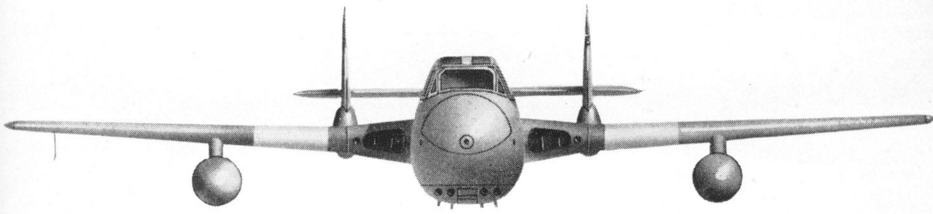
The Vampire Mk.2 was fitted with the 4,500 lb. thrust Rolls-Royce Nene R.N.1 to specification F.11/45, and three Vampire Mk.1 airframes were adapted to take the more powerful turbojet. Additional dorsal air intakes were fitted to feed the rear side of the Nene's double-sided compressor, but the production version, the Vampire Mk.4, was not proceeded with and the three Vampire Mk.2s served as prototypes for the Australian-built Vampire F.B.30. Eighty Vampire F.B.30 fighter-bombers powered by the 5,000 lb. thrust C.A.C.-built Nene 2-VH were built by De Havilland Aircraft Pty. Ltd. of Bankstown. Another Nene-powered variant of the Vampire has been built under licence in France by the S.N.C.A. de Sud-Est, under the designation Vampire F.B.53, or Mistral. The Mistral is powered by a 5,000 lb. thrust Hispano-Suiza Nene 102B turbojet fed by enlarged wing-root intakes, and has a maximum speed of 574 m.p.h. as compared to 570 m.p.h. for the Vampire F.B.30 and 548 m.p.h. for the Vampire F.B.9. Production of the Mistral was completed in 1954 after 247 machines had been built.

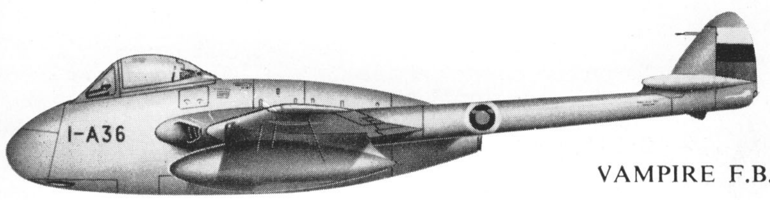
Two-seat night-fighter and trainer variants of the Vampire have also been produced. The former, the D.H.113 Vampire N.F. 10, was first flown on August 28, 1949, and was similar in most respects to the Vampire F.B.9 but for the two-seat cockpit which was substituted for the single seat, and American A.I.Mk.10 radar in an extended nose. Pilot and observer were seated side by side, and an export version was designated N.F.54. Armament comprised four 20-mm. cannon, maximum speed was 550 m.p.h. at 20,000 ft., and empty and maximum loaded weights were 6,984 lb. and 13,100 lb. The D.H.115 Vampire T.11 trainer, which first flew on November 15, 1950, had all essential cockpit instruments and controls duplicated and was otherwise basically similar to the N.F.10. Power is provided by a 3,500 lb. thrust Goblin 35 turbojet, maximum speed is 549 m.p.h. at 20,000 ft. and initial climb rate is 4,500 ft./min. Navalised and export versions are designated Sea Vampire T.22 and Vampire T.55 respectively, and an Australian production version is designated Vampire T.33.



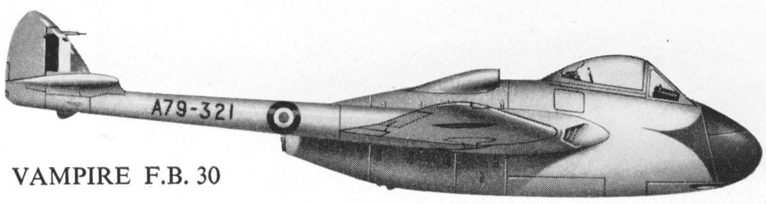


DE HAVILLAND VAMPIRE
T. 11



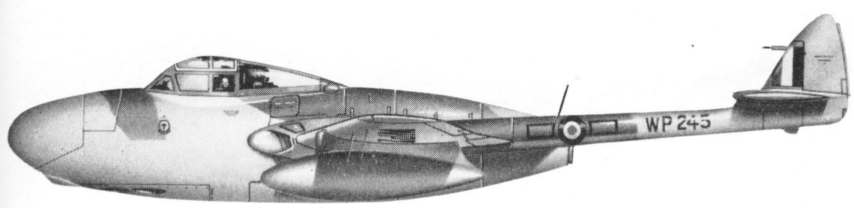


VAMPIRE F.B. 52



VAMPIRE F.B. 30

VAMPIRE N.F. 10



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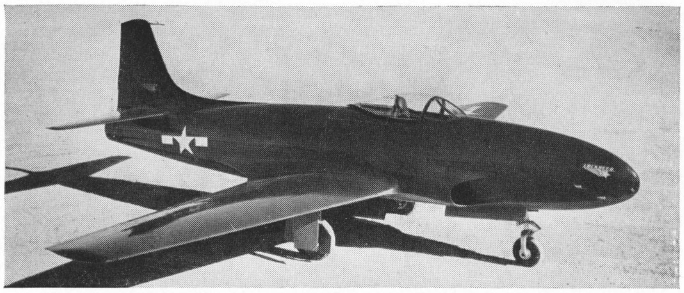
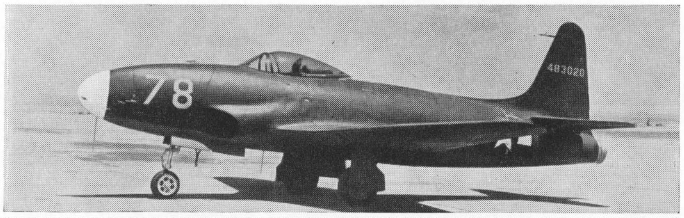
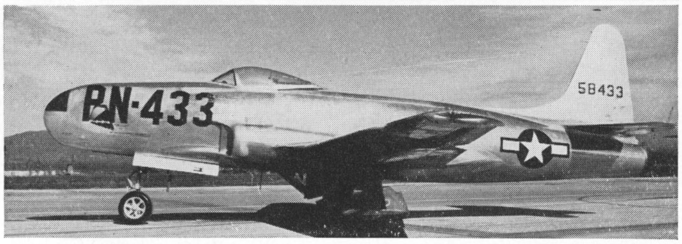
FEET

LOCKHEED F–80 (T-33) SHOOTING STAR (JANUARY) 1944

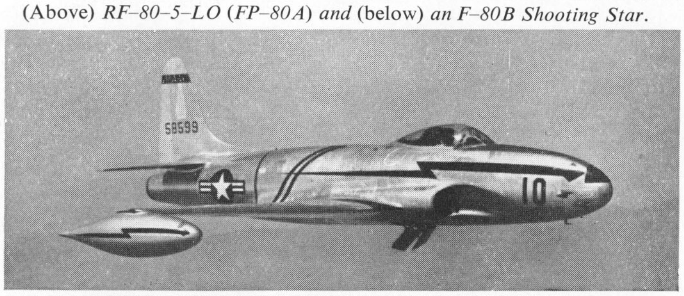


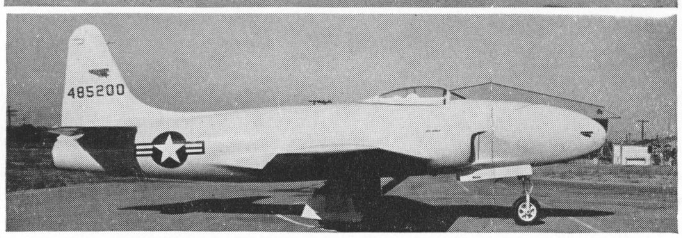
(Above) *XP–80 with de Havilland H–1B turbojet.* (Below) *XP–80A.*



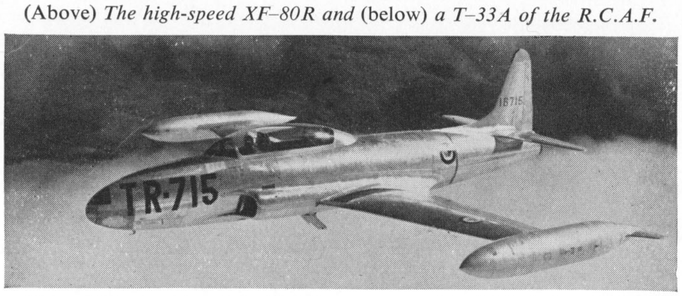


(Above) *RF–80–5–LO (FP–80A) and* (below) *an F–80B Shooting Star.*

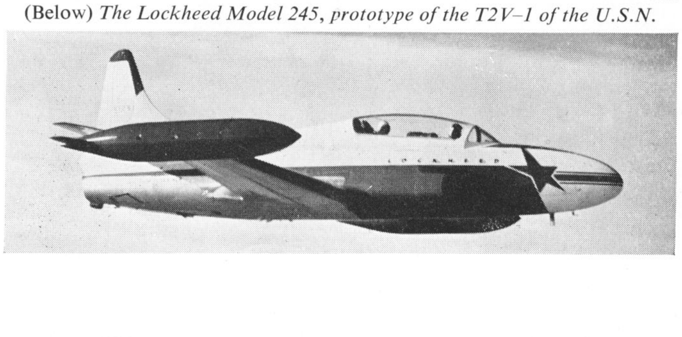




(Above) *The high-speed XF–80R and* (below) *a T–33A of the R.C.A.F.*



(Below) *The Lockheed Model 245, prototype of the T2V–1 of the U.S.N.*



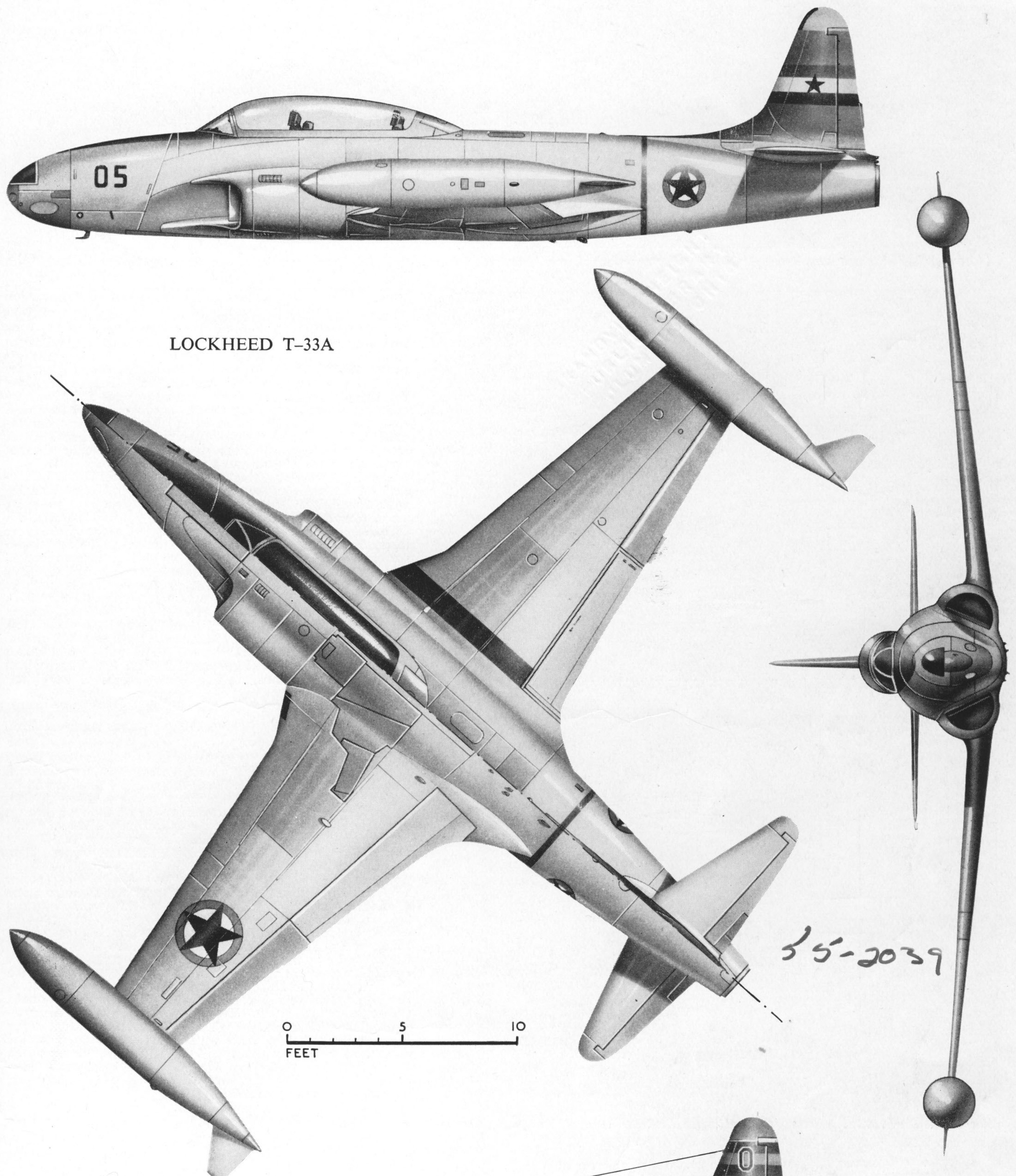
The F–80 Shooting Star single-seat fighter was the first jet combat aircraft to be accepted for operational service with the U.S.A.F. The first prototype, the XP–80, was designed around the 2,500 lb. thrust de Havilland H–1B (Goblin) turbojet, flying for the first time on January 8, 1944. Initial plans to power production aircraft with an Allis-Chalmers version of the H–1B did not reach fruition owing to production delays with this engine. The XP–80 was, therefore, extensively redesigned for the 3,850 lb. thrust General Electric I–40 (J33) engine. Fuselage length was increased from 32 ft. 10 in. to 34 ft. 6 in. and featured extensively redesigned air intakes and ducting, the loaded weight of 8,916 lb. was increased by 25 per cent, necessitating a redesigned undercarriage, and in order to maintain the same wing loading wing span was increased from 37 ft. to 38 ft. $10\frac{1}{2}$ in. Designated XP–80A, the first of two I–40–powered prototypes flew on June 10, 1944.

The first of thirteen service test YP–80A fighters was delivered in October 1944, and deliveries of the first basic production model, the F–80A, commencing nine months later. Successive production batches of the F–80A were powered by the 3,850 lb. thrust General Electric J33–GE–9, J33–GE–11 and Allison J33–A–17 engines, and 676 fighters of this type were built. The F–80A had an armament of six 0·5-in. M–3 guns, and empty and loaded weights were 7,920 lb. and 14,000 lb. respectively. Internal fuel capacity of 373 Imp. gal. could be augmented by wingtip tanks containing a further 260 Imp. gal., which increased range from 625 miles to 1,100 miles. Maximum speed was 558 m.p.h. at sea level, and initial climb rate was 4,580 ft./min.

The F–80A was succeeded in production by the F–80B, with a thinner wing to increase the critical Mach number, several internal refinements and a more powerful J33–A–21 turbojet of 4,000 lb. thrust and 5,200 lb. thrust with water injection. Serving F–80A fighters were brought up to F–80B standard, and 240 F–80Bs were built. The XF–80B prototype was modified in 1947 for an attempt on the World Air Speed Record. A J33–A–23 engine with a dry thrust rating increased to 4,600 lb. was installed and the XF–80R raised the World Air Speed Record to 623·8 m.p.h. on June 19, 1947. The final single-seat fighter model to be produced in quantity, the F–80C, initially employed a production model of the J33–A–23 engine used by the XF–80R and, later, the J33–A–35, which gave 5,400 lb. thrust with water injection. The F–80C had a maximum speed of 594 m.p.h. at sea level and weighed 8,240 lb. empty and 15,336 lb. loaded. A total of 798 F–80C Shooting Stars was built, some being supplied as trainers to the U.S. Navy under the designation TV–1. Versions of the Shooting Star remaining in service include the QF–80A target drone.

On August 25,1947, a standard F–80C fighter was taken from the production line and a new 3 ft. $2\frac{1}{2}$ in. fuselage section inserted containing a second seat. Designated TF–80C, the two-seat model flew for the first time on March 22, 1948, and, redesignated T–33A, has since been produced in large quantities as a conversion trainer. Powered by a 4,600 lb. thrust (5,400 lb. thrust with water injection) J33–A–35, the T–33A has a maximum speed of 580 m.p.h. and an initial climb rate of 5,525 ft./min. Range is 1,345 miles, and empty and maximum loaded weights are 8,084 lb. and 14,442 lb. respectively. The T–33A is used by the U.S. Navy as the TV–2 and, as the T–33A–N Silver Star Mk.3, is built under licence in Canada by Canadair Limited. The Silver Star is powered by a 5,100 lb. thrust Rolls-Royce Nene 10, and the first production aircraft was delivered to the R.C.A.F. in January 1953.

A single-seat tactical reconnaissance variant of the T–33A, the RT–33, has a battery of four mapping and charting cameras in the nose, and a wire recorder to enable the pilot to make a record of the flight over the target area. Operational range is 20% greater than that of the T–33A. An improved and more powerful version of the T–33A was flown for the first time on December 15, 1953. Originally known by the manufacturer's designation L–245 and built as a private venture, the new model is in production for the U.S. Navy as the T2V–1, and is powered by a 5,200 lb. thrust J33–A–16A turbojet. Slats are fitted to the wing to reduce stalling speed and improve low-speed lateral control, the instructor's seat is raised 6 in. above that of the pupil for improved visibility, and a tail braking parachute is installed. The vertical tail surfaces are taller than those of the T–33A and the horizontal surfaces have been raised clear of the fuselage. The overall dimensions of the T2V–1 are: span, 424 ft., length, 38 ft.; height, 13 ft.



LOCKHEED T–33A

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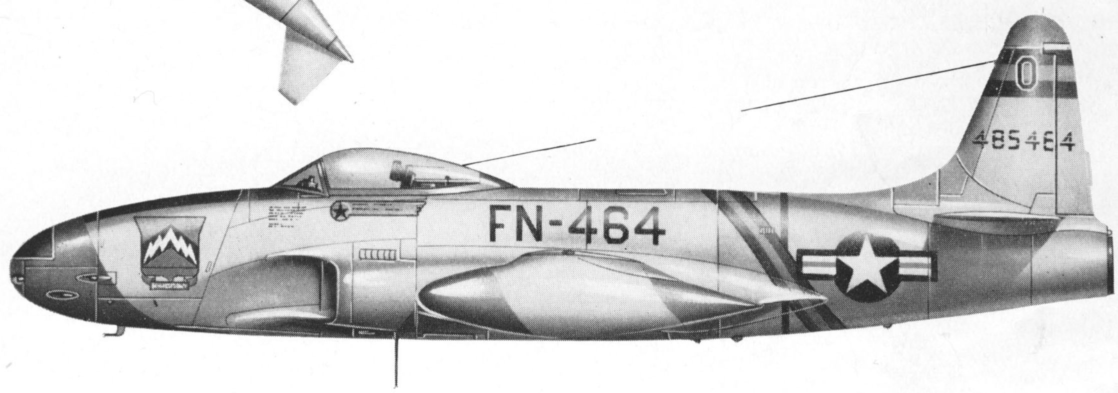

LOCKHEED F–80C
SHOOTING STAR

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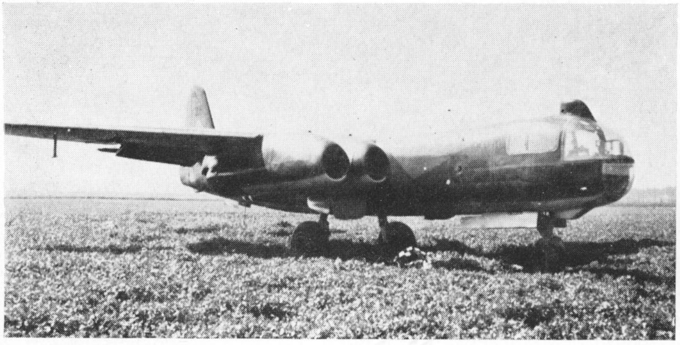
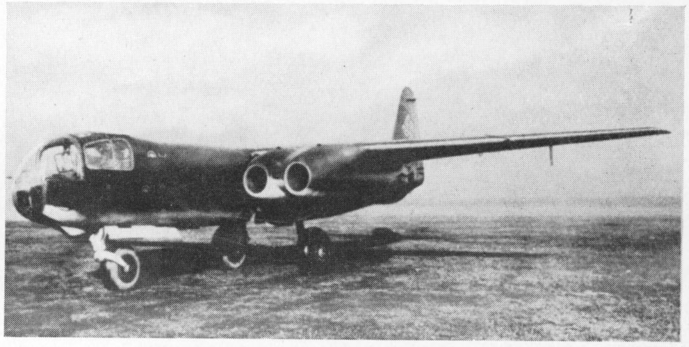
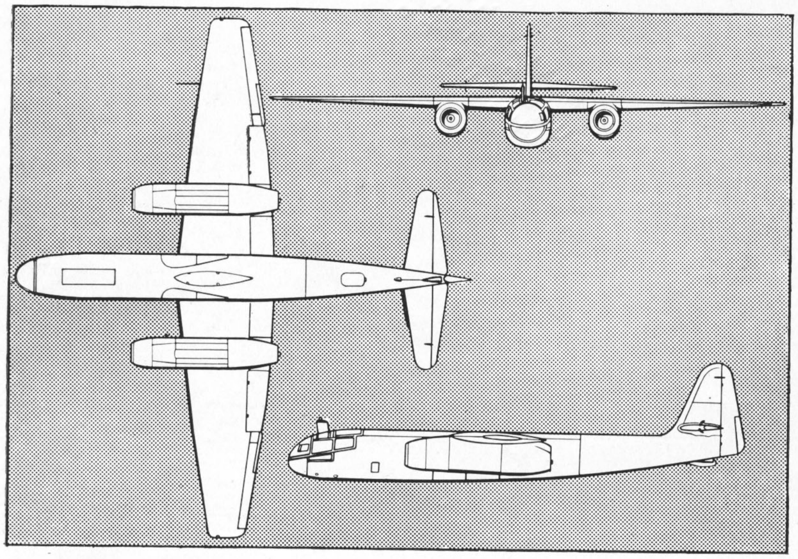




(Above, left) *The single-seat Arado Ar 234C–3, nineteen of which were built, and* (right) *the Ar 234V–21 two-seat prototype. Drawing depicts the Ar 234B–2.*

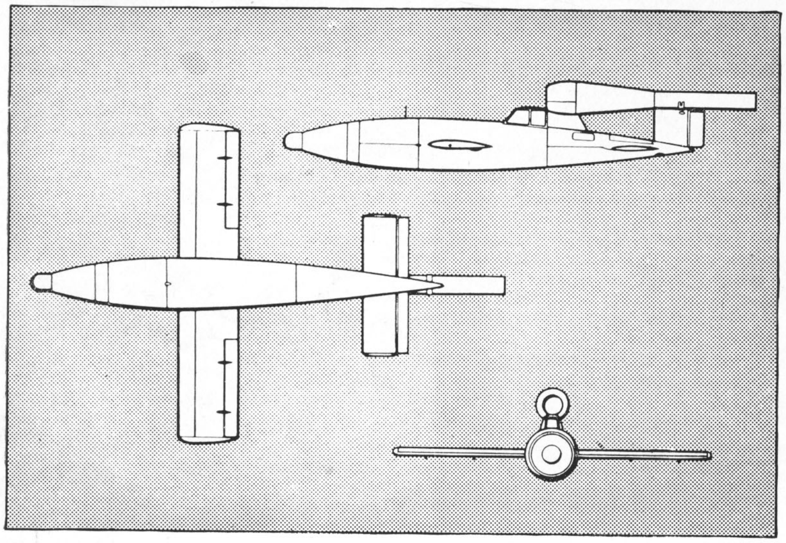


ARADO AR 234B–2 BLITZ (JUNE) 1943

The Ar 234B was the first production jet aircraft to be designed for the attack-bomber role. First flown on June 15, 1943, the first prototype, Ar 234V–1, used a jettisonable trolley for take-off and retractable skids for landing as did the next seven prototypes (V–2 to V–8), and this equipment was proposed for the first production version, the Ar 234A–1. However, later prototypes and all production machines were fitted with an orthodox nosewheel undercarriage. The first production models were the Ar 234B–1 and B–2 reconnaissance and bomber aircraft respectively, of which 210 examples were built. These were powered by two Junkers Jumo 004B turbojets, but three of the B-series prototypes had B.M.W.003A–1 turbojets.

The Ar 234B was being replaced by the Ar 234C, in production at the end of the war, but only 19 Ar 234C–3 bombers were completed. Prototypes of the C-series (V–19 to V–30) were, like the Ar 234C–3, powered by four B.M.W.003A turbojets in paired nacelles, but the V–21 and V–26 were two-seaters whereas all previous machines had been single-seaters. The C–3 appeared early in 1945 and was intended to fulfil both night-fighter and bomber roles. The C–4 was to have been a single-seat reconnaissance aircraft and the C–5 and C–6 two-seat bombers. A later series, the Ar 234D, was to have been powered by Heinkel-Hirth HeS 011 jets.

The Ar 234B–2 was powered by two Jumo 004B–4 turbojets of 1,890 lb. thrust each. Maximum speed was 470 m.p.h. at 19,680 ft., and service ceiling was 37,700 ft. Normal loaded weight was 18,500 lb. (including 3,300 lb. bomb load); and dimensions were: span, 47 ft. 4½ in.; length, 41 ft. 7½ in.

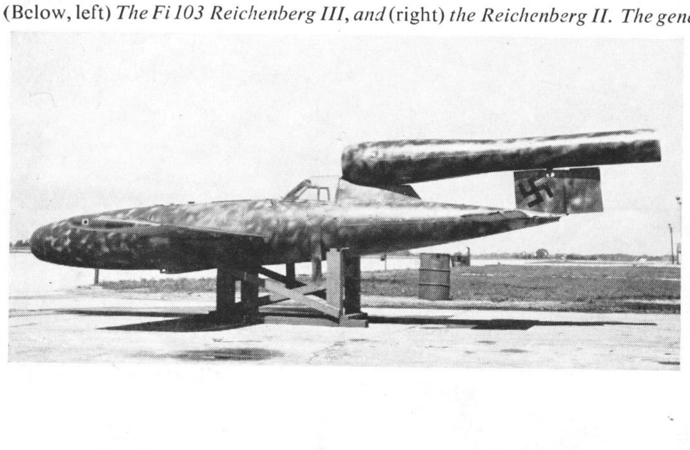


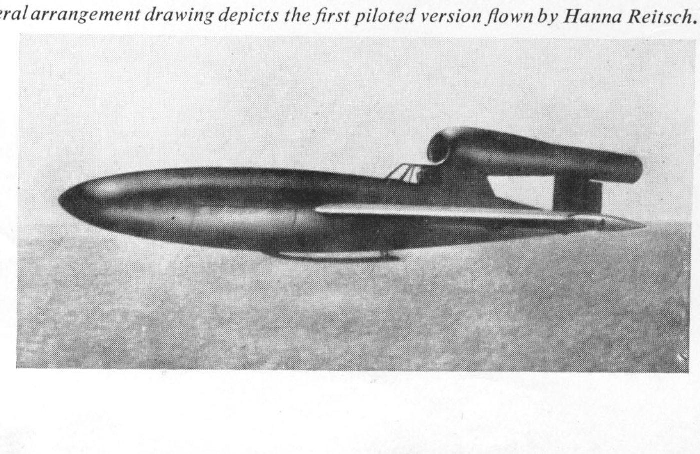
FIESELER FI 103 (APRIL) 1944

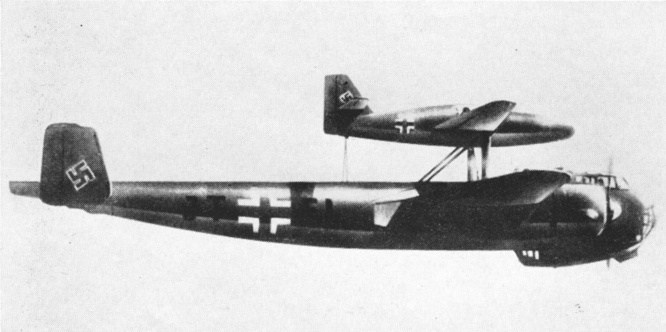
The Fi 103, designed by Gerhardt Fieseler and frequently referred to as the FZG 76, or "V1" (*Vergeltungswaffe Eins*—Reprisal Weapon One), was designed in 1942 as a pilotless missile powered by a 740 lb. thrust Argus As 014 impulse duct. The Fi 103, which, incidentally, was the first offensive weapon to be driven by jet-propulsion, was a simple cantilever monoplane with the propulsive duct carried above the rear fuselage and a 1,870-lb. warhead in the nose. Range was 150 miles and maximum speed was 360 m.p.h. The prototype Fi 103 was tested as a glider in December 1942, the first powered flight being made the same month.

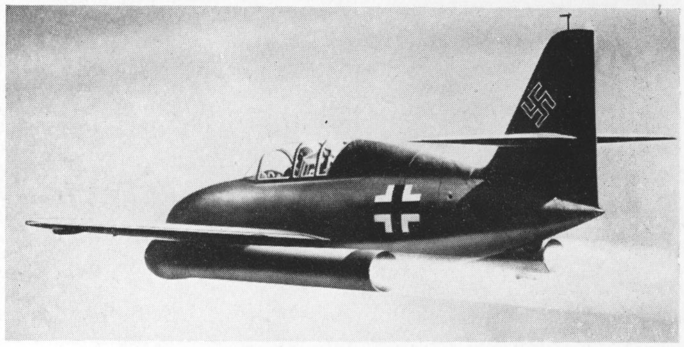
The piloted version was identical to the missile except for ailerons added to the standard wings, cockpit, controls and flight instruments installed just forward of the power plant, and landing skids. The Fi 103 was first flown in April 1944 by Fraulein Hanna Reitsch. A piloted version similar to that tested by Fraulein Reitsch was then proposed to combat seaborne landings, it being intended that the missile should be carried by a parent aircraft, released over the target area, the pilot directing the Fi 103 at a target and then baling out. A two-seat trainer version with increased wing span and without the Argus pulse duct was known as the *Reichenberg I*. A single-seat trainer variant with the pulse duct and a skid undercarriage but without warhead was known as the *Reichenberg II*, and the operational version without skid and with a warhead was the *Reichenberg III*. A total of 175 piloted Fi 103 aircraft were modified from standard pilotless missiles at Dannenburg, but were not used operationally.

(Below, left) *The Fi 103 Reichenberg III, and* (right) *the Reichenberg II. The general arrangement drawing depicts the first piloted version flown by Hanna Reitsch.*









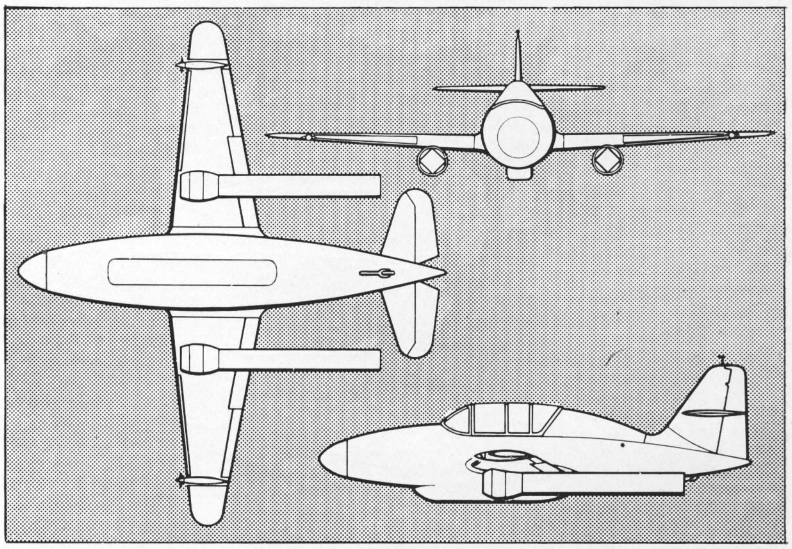
(Above, left) *The Me 328A carried aloft by Dornier Do 217E–2 for gliding tests.* (Right) *Artist's impression of the Me 328B.*

MESSERSCHMITT ME 328B (JUNE) 1944

The Me 328B was projected early in 1943 as an inexpensive high-performance fighter and ground-attack aircraft, development being entrusted to the Jacobs Schweyer glider-manufacturing company. The initial version, the Me 328A, was intended as a light interceptor, but changes in tactical requirements led to the discontinuation of the A sub-type in favour of the Me 328B attack version. This was built primarily of wood and had a jettisonable wheel undercarriage for take-off and a retractable skid for landing. Power was provided by two 880 lb. thrust Argus As 014 impulse ducts, and it was proposed that a 500-kg. bomb should be carried in a crutch under the fuselage.

The first prototype, the Me 328V–1, was completed early in 1944 for trials as a glider. For these tests the aircraft was launched at altitude from a launching structure fitted to a Dornier Do 217E–2. Several prototypes were built, and one fitted with As 014 ducts flew in June 1944. Excessive vibration initiated by the pulsation of the Argus ducts resulted in the disintegration of the machine and the abandonment of the project. A further version, the Me 328C, was proposed with a single Junkers Jumo 004B–2 turbojet.

The Me 328B had an estimated maximum speed of 503 m.p.h. at sea level, and 435 m.p.h. at 10,000 ft. With a 500-kg. bomb the speed at sea level was reduced to 455 m.p.h. Range was 330 miles (305 miles with bomb), and service ceiling was 13,100 ft. Initial climb rate with bomb was estimated at 2,360 ft./min., and loaded weight was 8,220 lb. Dimensions were: span, 27 ft.; length, 23 ft. 7 in.; wing area, 91·5 sq. ft.

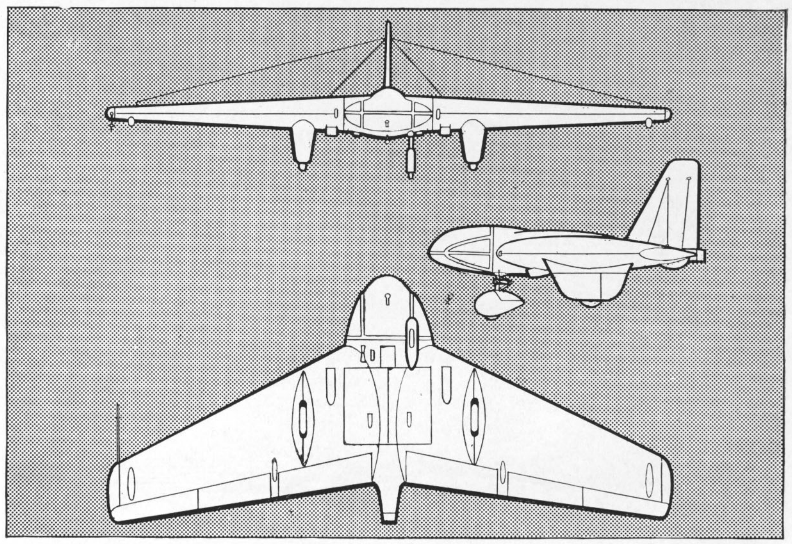


NORTHROP MX–324 (JULY) 1944

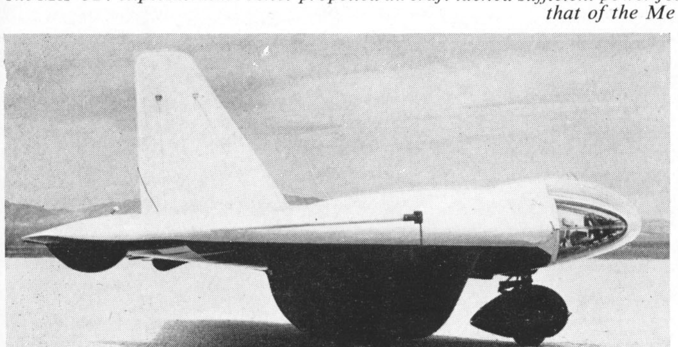
In September 1942, Northrop Aircraft conceived the idea of using liquid rocket motors in a flying-wing fighter, totally unaware that this development had already been successfully tested in Germany. A U.S.A.A.F. development contract was awarded in 1943, and an extensive programme of control and stability tests was commenced with three full-size glider models of the proposed rocket-driven aircraft. As the physical dimensions of the pilot were the limiting size factor, it was decided that the pilot should lie prone in the fuselage to reduce drag. Known by the experimental number MX-324, and powered by an Aerojet XCAL-200 rocket motor using monoethylaniline oxidised with red fuming nitric acid, the rocket-propelled aircraft flew for the first time on July 5, 1944.

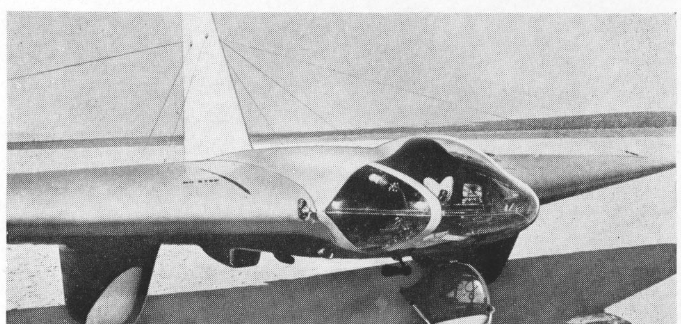
The MX-324 was built primarily to test the practicability of rocket power for aircraft, and the XCAL-200 rocket motor, which weighed 427 lb., gave only 200 lb. thrust. For its first powered flight the MX-324 was towed to 8,000 ft. by a Lockheed P-38 Lightning and, after casting off from its tug, flew under power for five minutes.

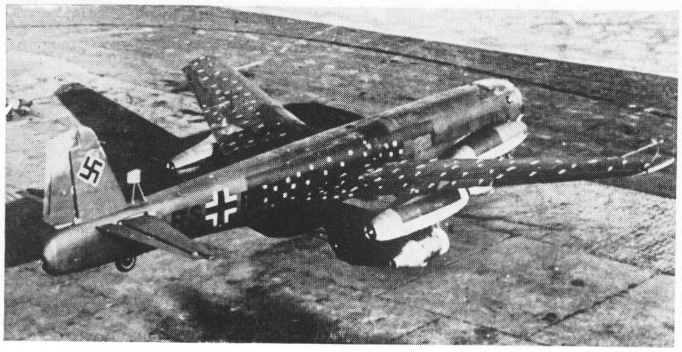
The MX-324 had a wing span of approximately 30 ft. and a fixed "trousered" undercarriage. The rocket motor, complete with four pressure tanks and two propellent tanks, was housed within the wing. Several successful rocket flights were made, but owing to the low thrust available performance was poor and endurance extremely limited, and proposals to install more powerful rocket units were not accepted owing to the limited space available for fuel tanks sufficient to provide a reasonable endurance for flight testing.

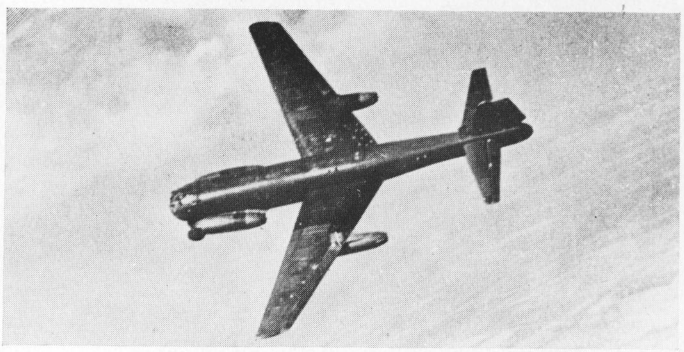


The MX–324 experimental rocket-propelled aircraft lacked sufficient power for high-speed flight. Its general arrangement makes interesting comparison with that of the Me 163B (page 42).

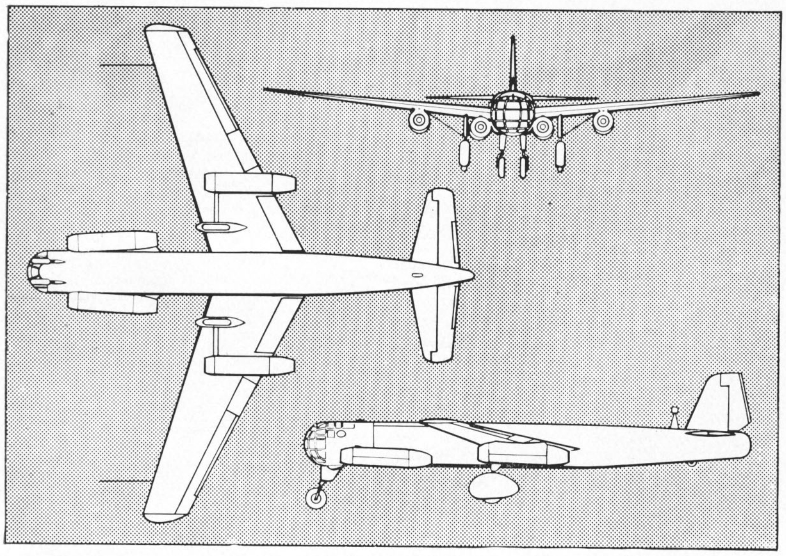








The Ju 287V–1 utilised major components from several aircraft types and was the world's first jet medium bomber.

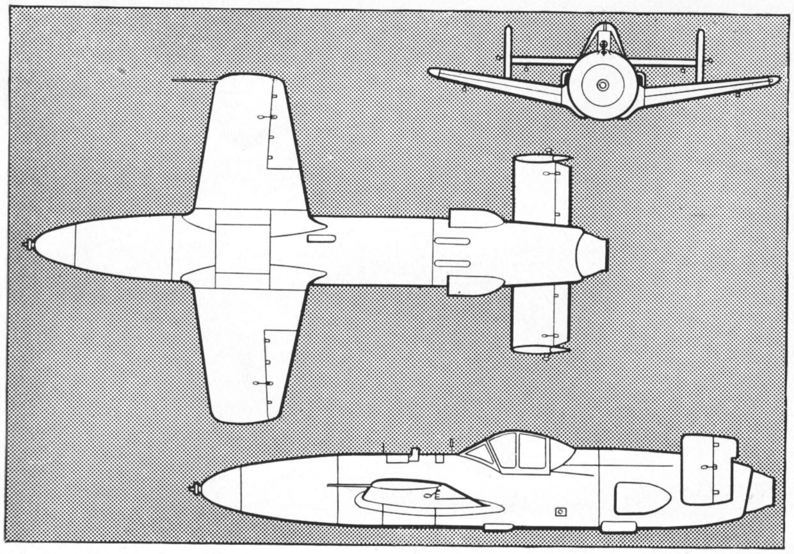


JUNKERS JU 287V–1 (AUGUST) 1944

The Junkers Ju 287V-1 was of unusual interest. The world's first jet-propelled medium bomber to fly, its wing featured pronounced *forward* sweep in an attempt to increase its critical Mach number, simultaneously avoiding the problem of wing-tip stalling associated with the swept*back* wing.

Work on the Ju 287 was initiated in the summer of 1943, and in order to reduce the normal prototype construction period the first prototype, the Ju 287V-1, utilised major components of several well-tried aircraft. The fuselage was derived from the Heinkel He 177, the tail unit from a Junkers Ju 188, and the undercarriage was from a captured Convair B-24. Thus the only new major airframe component was the wing, which, attached to the fuselage at mid point, had a span of 65 ft. 11¾ in., an area of 627·5 sq. ft., and was swept forward 20°. Four 1,980 lb. thrust Junkers Jumo 004B turbojets were fitted, and for take-off their thrust was augmented by four Walter 501 rockets delivering 2,640 lb. thrust each for 40 sec.

The Ju 287V-1 flew for the first time on August 16, 1944, at Brandis airfield, near Leipzig, and during flight tests attained a top speed of 404 m.p.h. Empty and loaded weights were 27,557 lb. and 44,092 lb. A second prototype, the Ju 287V-2, powered by six BMW 003A-1 turbojets, was under construction at the end of the war, as was also the production prototype, the Ju 287V-3. The latter was to have had a maximum speed of 537 m.p.h. and a range of 4,166 miles with a 6,600-lb. bomb load. These were to have had retractable undercarriages, and four turbojets were to have been mounted in paired underwing pods and two at the fuselage sides.



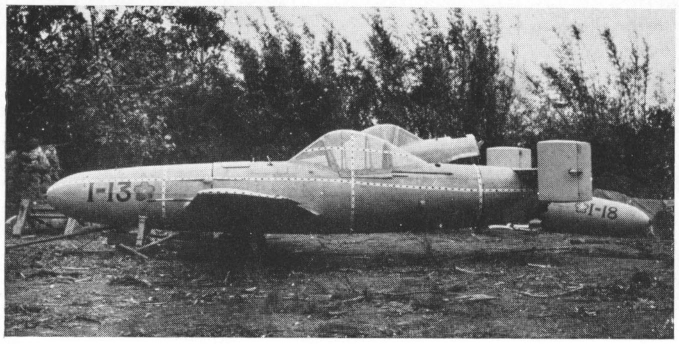
OKA (SEPTEMBER) 1944

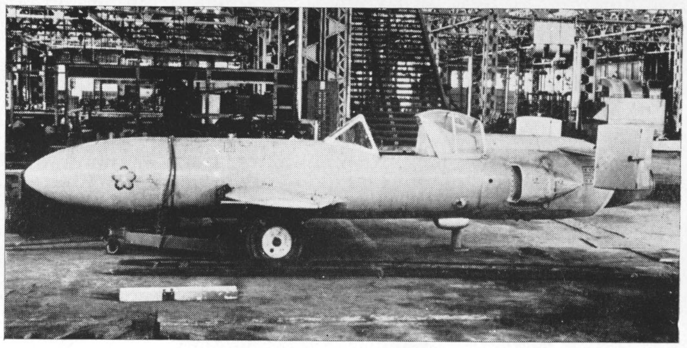
Conceived primarily as a piloted missile for suicide attacks, the Oka (Cherry Blossom) single-seat, rocket-propelled aircraft first flew in September 1944 powered by three Type 4 Mk. I Model 20 rockets which gave an approximate thrust of 1,763 lb. for 8–10 sec. The Oka Model 11 was normally carried semi-externally in the bomb-bay of a Mitsubishi G4M2, being launched in the proximity of the target, the warhead carrying 2,645 lb. of trinitroanisole. After launching at some 27,000 ft., the Oka 11 could glide some 50 miles at 230 m.p.h. and, with rocket power, during the final approach, speed became 534 m.p.h., and at a 50° angle 620 m.p.h. Dimensions were: span, 16 ft. 5 in.; length, 19 ft. 11 in.; wing area, 64·56 sq. ft. Empty and loaded weights were 970 lb. and 4,718 lb. respectively. A total of 755 was built between September 1944 and March 1945.

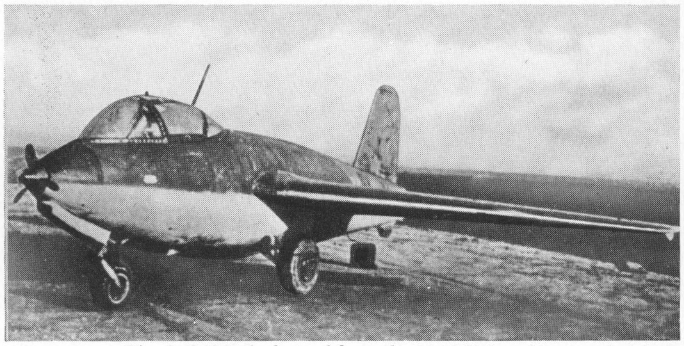
The Oka 11 was supplanted in production by the Oka 22, which utilised a Tsu-11 turbojet. Weighing 1,201 lb. empty and 3,197 lb. loaded, the Oka 22 had the following dimensions: span, 13 ft. 6 in.; length, 22 ft. 7 in.; wing area, 43·4 sq. ft.

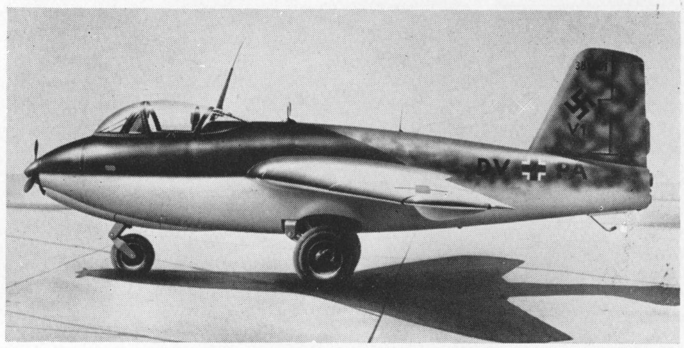
Further developments included the Oka 43, which was designed around the 1,047 lb. thrust Ne-20 turbojet and was to have been catapult-launched. The Oka 43 would have carried an armament of two 20-mm. cannon and was to have been operated as a simple lightweight fighter. Span was increased to 26 ft. 3 in., length was 26 ft. 9 in., and loaded weight was 5,512 lb. An unpowered training version of the Oka was designated MXY7. Only the Oka 11 was employed operationally.

(Below, left) *The rocket-powered Oka 11, and* (below, right, and g.a. drawing) *the turbojet-driven Oka 22.*



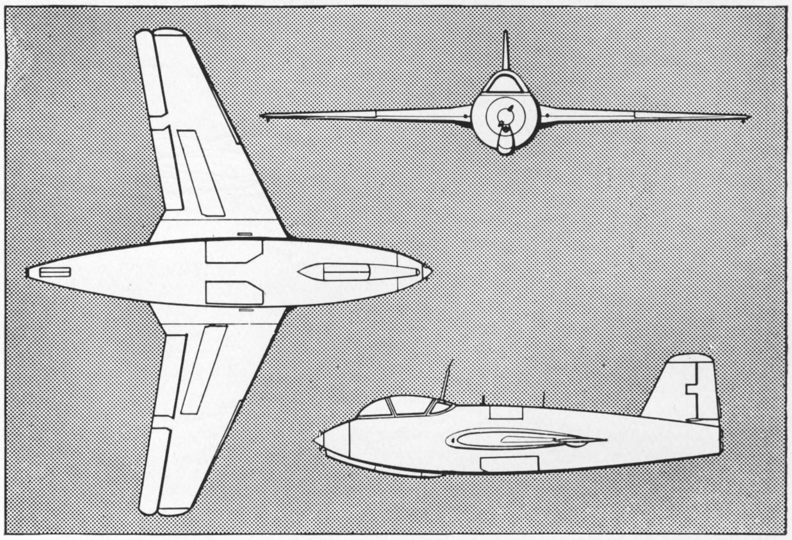






The Ju 248 V–1, derived from the Me 163C and later redesignated Me 263A, was about to enter production at end of World War II.

JUNKERS JU 248V–I (SEPTEMBER) 1944

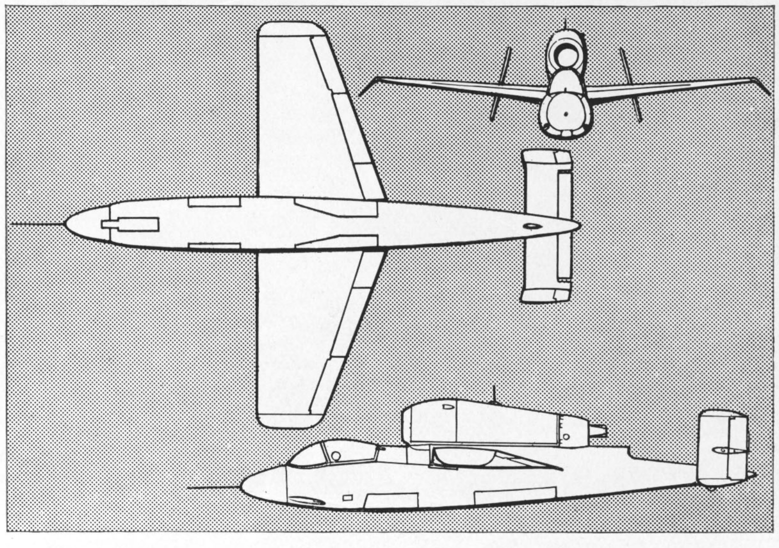


The Ju 248 rocket-driven interceptor fighter was a Junkers development of the Lippisch-designed Messerschmitt Me 163C embodying considerable redesign and improved operational characteristics. The sole prototype, the Ju 248V-1, was completed at the Junkers Dessau factory in August 1944, and was initially tested as a glider, the first powered flight being made towards the end of the following month. After initial flight trials, development of the Ju 248 was taken over by the Messerschmitt A.G. and the type redesignated Me 263, but no further prototypes were completed.

The Ju 248V-1 featured a completely redesigned fuselage with a better fineness ratio than that of its predecessor. The landing skid was eliminated and replaced by a nosewheel undercarriage. The undercarriage of the prototype was fixed, but that of production machines was to have been fully retractable. The wing accommodated slightly larger fuel tanks and, together with the fuselage tanks, total fuel capacity comprised 352 Imp. gal. of *T-stoff* and 185 Imp. gal. of *C-stoff*.

The Walter 109-509C rocket motor, with an auxiliary cruising chamber, gave a maximum thrust of 4,400 lb. and had an endurance of 15 min. at 496 m.p.h. Maximum speed was 590 m.p.h., and climb rate at sea level was 11,800 ft./min. and 33,500 ft./min. at 32,800 ft. Empty and loaded weights were 4,850 lb. and 11,650 lb. respectively, and armament comprised two 30-mm. MK 108 cannon. The pilot was seated in a pressurised cockpit with adequate armour protection. Overall dimensions were: span, 31 ft. $2\frac{1}{2}$ in.; length, 26 ft.; wing area, 192·8 sq. ft.

HEINKEL HE 162A–I (DECEMBER) 1944

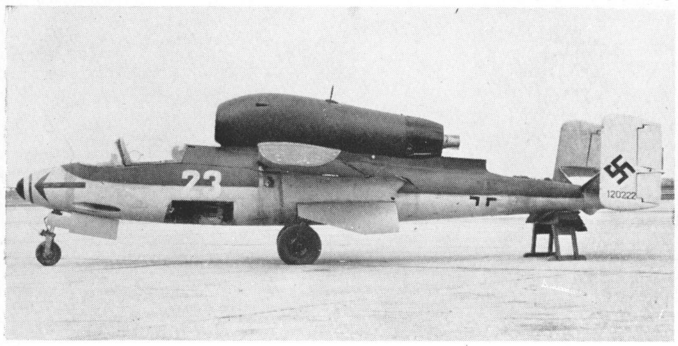


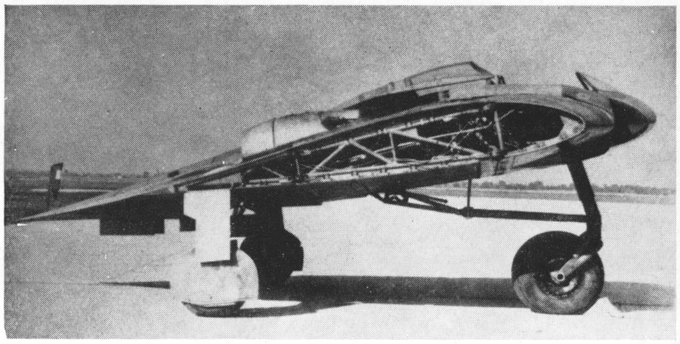
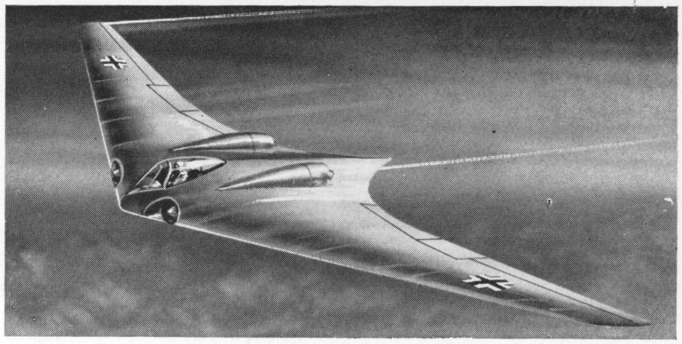
Known as the *Volksjäger* (People's Fighter), the He 162 was built in sixty-nine days, the development contract being placed on September 29, 1944, and the first prototype, the He 162V-1, flying on December 6, 1944. Developed as an emergency interceptor suitable for mass production by semi-skilled labour from non-priority materials, the He 162 was of mixed construction and powered by a 1,760 lb. thrust B.M.W.003A-1 turbojet mounted above the fuselage aft of the pilot's cockpit. A monthly production rate of several thousand He 162A-1 fighters was envisaged, but only 116 were completed.

The He 162A-1 carried an armament of two 30-mm. MK 108 cannon and, with a take-off weight of 5,500 lb., had a speed of 522 m.p.h. at 19,700 ft. and 490 m.p.h. at sea level. Full-throttle endurance at sea level was only 20 min., but at 36,000 ft. became 57 min., at which altitude range was 410 miles. Initial climb rate was 4,230 ft./min. Overall dimensions were: span, 23 ft. $7\frac{3}{4}$ in.; length, 29 ft. $8\frac{1}{2}$ in.; wing area, 120 sq. ft.

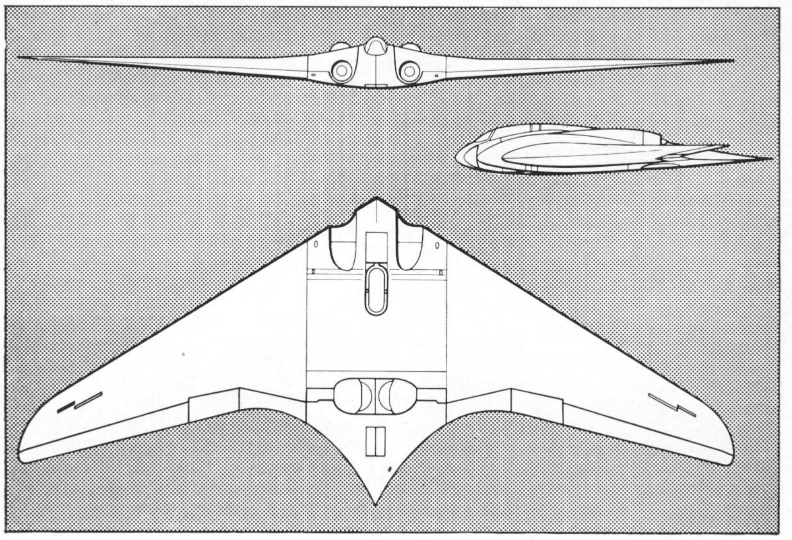
Several variants of the He 162 were projected, including versions powered by the B.M.W.003R combined turbojet/rocket unit which would have increased sea-level speed to 628 m.p.h., the B.M.W.003E-1 (with which sea-level top speed would have been 552 m.p.h.), and the Junkers Jumo 004D or E. A swept-wing version with a Heinkel HeS 011 turbojet was also projected, as were versions with a single Argus As 044 impulse duct of 1,100 lb. thrust and with two As 014 ducts of 780 lb. thrust. The first squadron equipped with the He 162A-1 fighter (JG 84 based at Leck in Schleswig Holstein) was about to become operational at the end of the war.

The He 162A–1 was the precursor of the modern lightweight utility jet fighter. The type was about to enter operational service at end of World War II.



(Above, left) *The Ho IX V–2 prior to the attachment of outer wing panels, and* (right) *an impression of the Go 229V–3.*

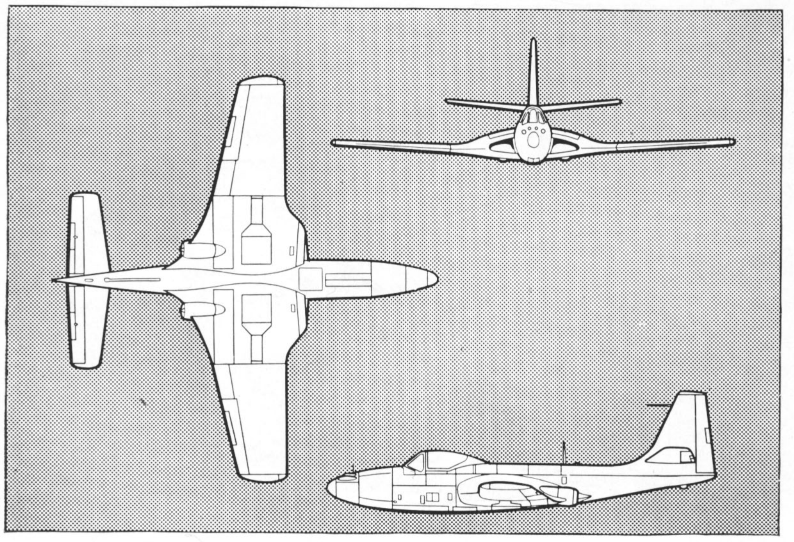


HORTON HO IX V–2 (JANUARY) 1945

The Horton Ho IX twin-jet fighter-bomber was of pure " flying-wing " design, the centre-section chord being increased to provide accommodation for the pilot and twin turbojets. Lateral and longitudinal control were effected by means of elevons, directional control being obtained from drag rudders of the spoiler type fitted above and below the wing.

It was intended to power the first prototype, the Ho IX V–1, with two 1,760 lb. thrust B.M.W.003A–1 turbojets; but as these units were not ready for installation, the aircraft was completed as a glider, and in this form flight testing commenced in 1944 at the *Deutsches Vershungsanstalt fur Luftfahrt*, at Oranienberg. The second prototype, the Ho IX V–2, was completed, with two 1,890 lb. thrust Junkers Jumo 004B turbojets, and flew for the first time in January 1945. The success of the initial flights resulted in the placing of an order for an initial production batch of thirty machines with the Gothaer Waggonfabrik of Friedrichsrode. The production model was to have been designated Gotha Go 229. However, after two hours of flight testing, the Ho IX V–2 was destroyed, and the production prototype, the Go 229V–3, had not been completed when development ceased.

The Gotha Go 229's estimated performance included a maximum speed of 590 m.p.h. at sea level, an initial climb rate of 4,300 ft./min., and a service ceiling of 52,000 ft. Maximum loaded weight (including a 4,400-lb. bomb load) was 18,700 lb., and fixed armament comprised four 30-mm. MK 108 cannon. Wing span was 52 ft. 6 in. and wing area was 566 sq. ft.



McDONNELL PHANTOM (JANUARY) 1945

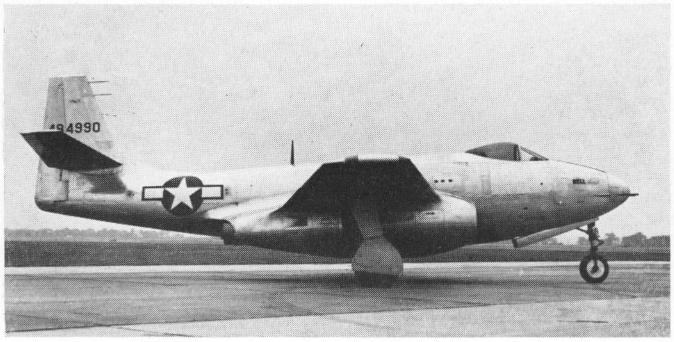
The first U.S. jet-propelled aircraft designed from the outset for shipboard operations, the McDonnell Phantom single-seat fighter became the first American jet aircraft to operate from a carrier at sea, flying from the U.S.S. *Franklin D. Roosevelt* on July 21, 1946.

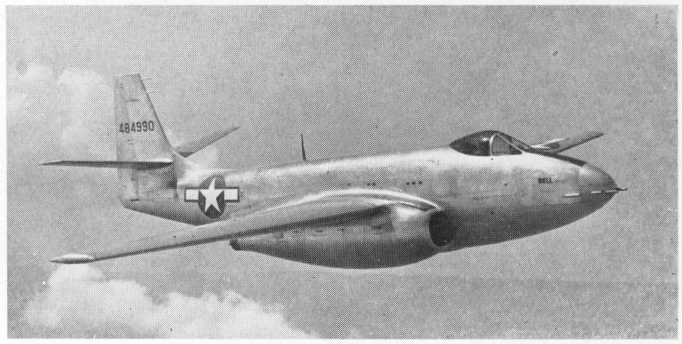
The McDonnell Aircraft Corporation began preliminary design studies of a jet-propelled, single-seat carrier-borne fighter in 1942, and alternative engine arrangements embodying eight 9·5.-in-dia. turbojets, six 11-in.-dia. turbojets, four 13·5-in.-dia. turbojets and two 19·5-in-dia. units were considered. The twin-turbojet arrangement was eventually chosen, and a U.S. Navy development contract was placed in January 1943.

Embodying two 1,365 lb. thrust Westinghouse J30–WE turbojets mounted in the wing roots alongside the fuselage and exhausting aft of the wing trailing edge, the first prototype, designated XFD–1, flew on January 25, 1945. Less than three months later, on March 7, the U.S. Navy placed an order for one hundred production aircraft. With the end of the Second World War this order was cut back to sixty machines, and the first production FH–1 Phantom was delivered late in 1946, the order being completed on May 27, 1948.

The FH–1 was powered by two 1,600 lb. thrust Westinghouse J30–WE–20 turbojets, which gave a top speed of 505 m.p.h. at 40,000 ft., a range of 690 miles (which could be increased to 1,400 miles by the addition of an under-fuselage tank) and a service ceiling of 43,000 ft. Empty and loaded weights were 6,683 lb. and 10,035 lb. respectively; and dimensions were: span, 40 ft. 9 in.; length, 38 ft. 9 in.

The XFD–1 Phantom (below, left), *the first U.S. carrier-borne jet fighter, and* (right) *a production FH–1 of VMF–122* (*U.S. Marine Corps*).





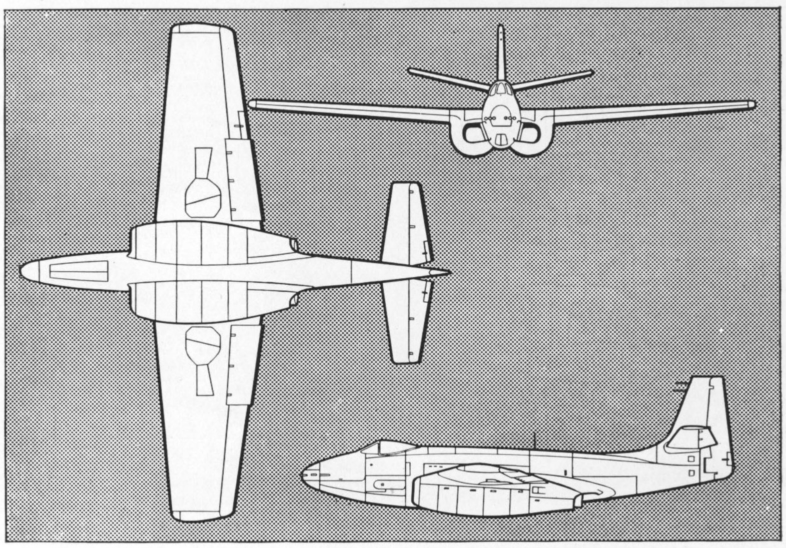
The first U.S. heavy long-range jet fighter, two prototypes of the XP–83 were tested, the first of which is illustrated above.

BELL XP–83 (FEBRUARY) 1945

The Bell XP–83 can be considered as the first in a new class of heavily loaded, single-seat long-range fighters, and the first U.S. attempt to solve the problem of limited operational radius that was a serious drawback in single-seat jet fighters then current. Internal fuel tankage being considered of paramount importance in the design of the XP–83 dictated a singularly bulky fuselage. This accommodated built-in fuel tankage totalling 912 Imp. gal., sufficient for a range of 1,730 miles at 30,000 ft. Internal tankage could be augmented by auxiliary jettisonable tanks containing a further 250 Imp. gal. of fuel which extended the maximum range to 2,050 miles.

The first of two XP–83 prototypes flew on February 25, 1945, and was similar in basic layout to its predecessor, the P–59A. The twin 4,000 lb. thrust General Electric J33–GE–5 turbojets were attached to the fuselage sides under the wing roots and, exhausting close to the fuselage centre line and exerting no appreciable asymmetric forces with one engine out, enabled the XP–83 to cruise on the power of one engine. Maximum speeds were 567 m.p.h. at sea level, and 525 m.p.h. at 45,000 ft. Initial climb rate was 5,650 ft./min.

The XP–83 possessed a loaded weight of 21,568 lb., although with a bomb load of 2,000 lb. it was proposed that overload weight should be 27,000 lb. Dimensions were: span, 53 ft.; length, 44 ft. 10 in.; height, 15 ft. 3 in.; wing area, 430 sq. ft. The proposed armament comprised six 0·50-in. Browning guns. Alternatively, four 20-mm. or 37-mm. guns could be installed, and a project existed for mounting *twenty* 0·50-in. guns in the nose.

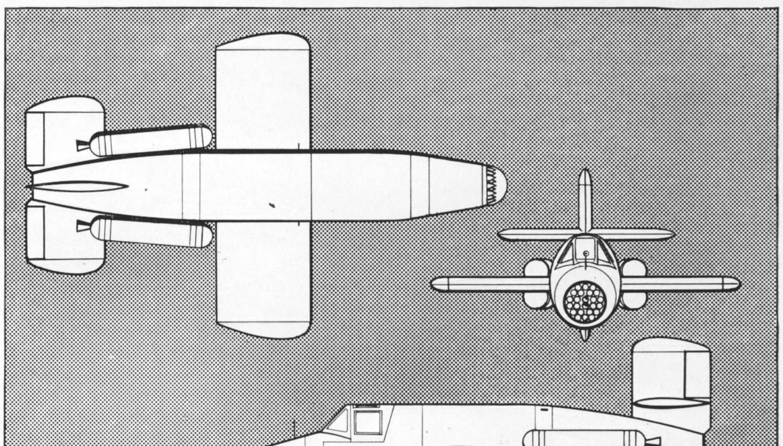


BACHEM BA 349A NATTER (MARCH) 1945

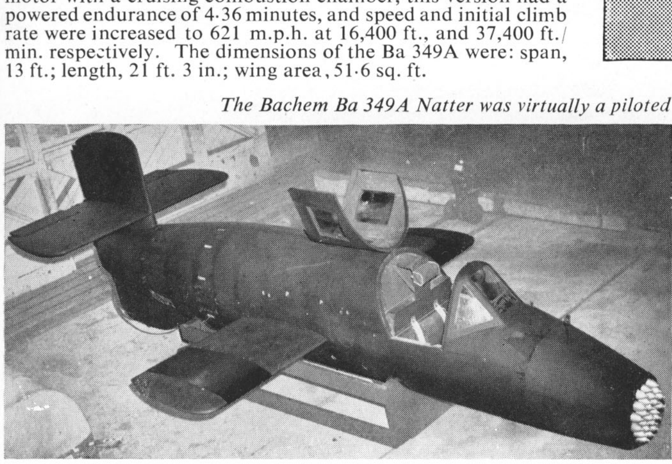
Design of the Ba 349A *Natter* (Viper) was begun in August 1944 by the Bachem Werke G.m.b.H. An inexpensive, semi-expendable fighter, the Ba 349A carried 33 R4M or 24 Föhn rocket missiles and was powered by a Walter HWK 109-509A bi-fuel rocket motor. It was launched by means of an 80-ft. near-vertical ramp and the power of the bi-fuel rocket motor was augmented at take-off by four solid-fuel rockets.

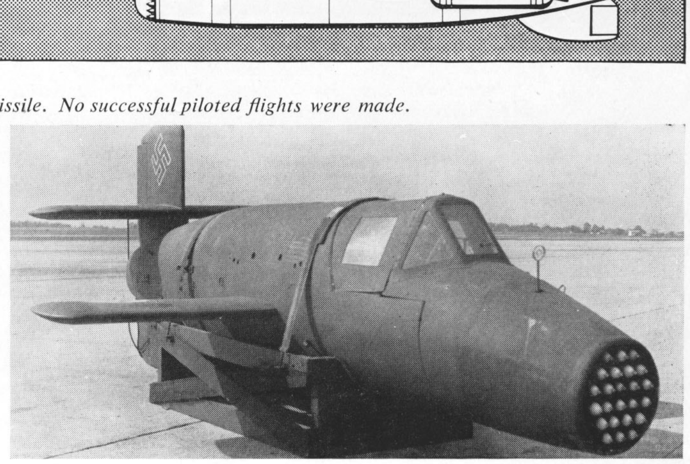
It was proposed that the Ba 349A should be guided to the vicinity of an enemy bombing formation by radio/radar link, whereupon the pilot would take control, fire his missiles and eject himself from the aircraft. Simultaneously the rocket motor would fall away from the main structure, being lowered to the ground by parachutes so that it could be used again. The first Ba 349A was launched on December 18, 1944, on the power of the four solid-fuel rockets. The Walter bi-fuel motor was not installed and the machine was pilotless. Ten similar launchings were made, and on February 25, 1945, another pilotless Ba 349A, but fitted with the Walter motor, was launched successfully. A piloted launching was then made but the aircraft was destroyed.

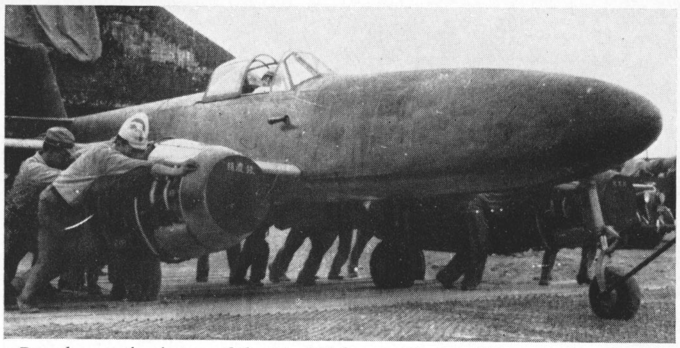
The Ba 349A weighed 4,800 lb. at take-off and its top speed and climb rate were 540 m.p.h. and 35,800 ft./min. respectively. Endurance was limited to 2 minutes and, to improve upon this, the Ba 349B was produced. Powered by a Walter 109-509D motor with a cruising combustion chamber, this version had a powered endurance of 4·36 minutes, and speed and initial climb rate were increased to 621 m.p.h. at 16,400 ft., and 37,400 ft./min. respectively. The dimensions of the Ba 349A were: span, 13 ft.; length, 21 ft. 3 in.; wing area, 51·6 sq. ft.

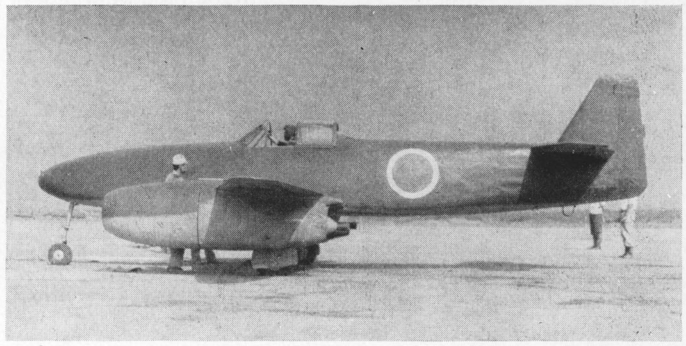


The Bachem Ba 349A Natter was virtually a piloted missile. No successful piloted flights were made.

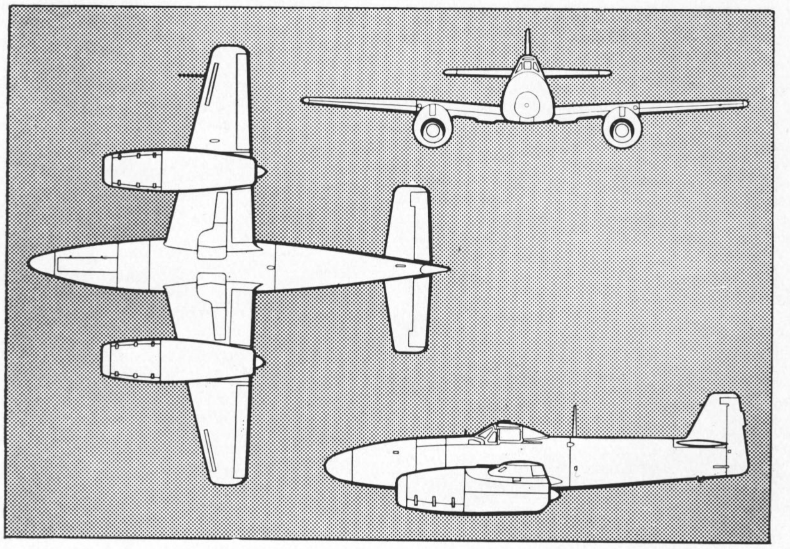








Based upon the design of the Me 262 (page 43) the Kikka was Japan's only gas-turbine-powered fighter to be tested. Two prototypes were built, the first of which is illustrated here.

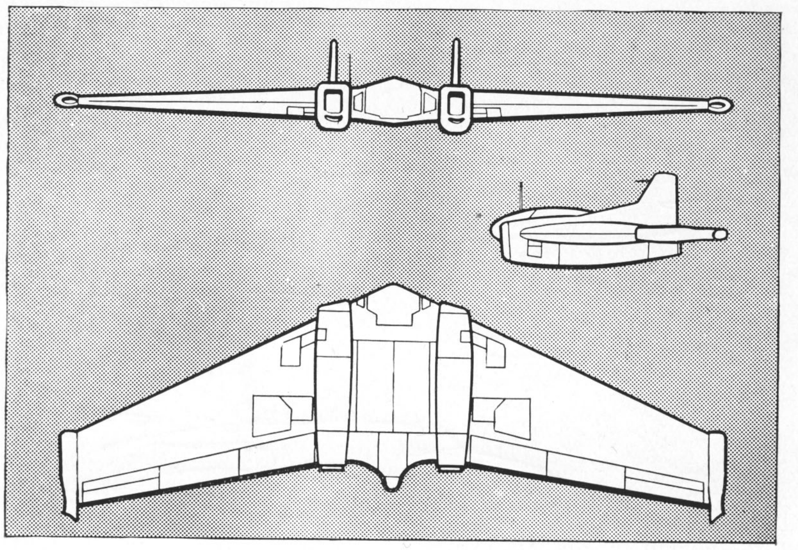


NAKAJIMA J8NI KIKKA (AUGUST) 1945

The Nakajima J8N1 *Kikka* (Sacred Blossom) was the only gas-turbine-propelled fighter to be produced by Japan during World War II. The *Kikka* was designed by the Nakajima company in collaboration with the Naval Air Research Establishment to meet a specification for a twin-jet fighter-bomber issued by the Imperial Japanese Navy in December 1944. The design of the *Kikka* was strongly influenced by that of the Messerschmitt Me 262—a slightly modified version of the Me 262 was, in fact, under construction in Japan at the end of the war under the designation Ki-201 *Karyu* (Fire-Dragon)—and simplicity of construction was a major feature.

The first of two prototypes was completed on June 25, 1945, and was flown for the first time on August 7 by Lt. Comdr. Takaoka at the Kisazuru Naval Air Base. This flight, which had a duration of eleven minutes, was successful, but the second flight (August 11) resulted in the destruction of the prototype. The second prototype was not test-flown and was later taken to the U.S.A. Quantity production of the *Kikka* had been ordered in February 1945 and it was planned that ninety-four machines would be produced during the period July-September. However, damage to the factories and shortage of materials precluded the completion of any production aircraft.

The *Kikka* was powered by two 1,050 lb. thrust Ne-20 axial-flow turbojets (scaled-down version of the German BMW 003) and had a designed maximum speed of 422 m.p.h. at 19,700 ft., and a range of 345 miles. Empty weight was 5,070 lb. and loaded weight 7,826 lb. Dimensions: span, 32 ft. 10 in. (17 ft. 3 in. folded); length, 30 ft. 4 in.; wing area, 142·14 sq. ft.



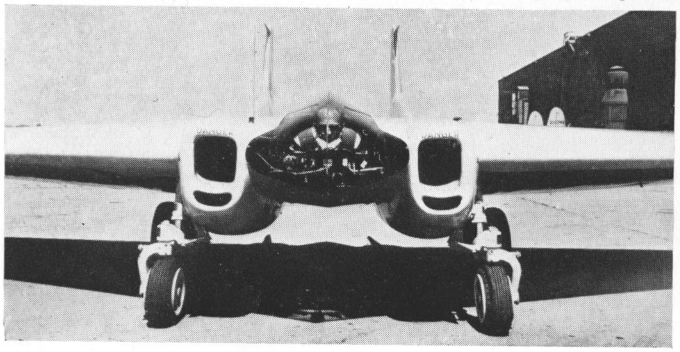
NORTHROP XP–79B (SEPTEMBER) 1945

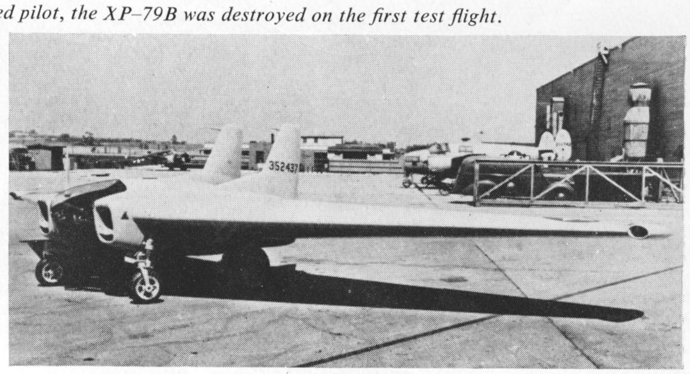
Ramming enemy aircraft was practised during the Second World War by the Soviet and Japanese air forces and considered by the Germans, and the XP-79B was unique in being the first jet aircraft designed specifically for ramming. Derived from the XP-79 and XP-79A, which were projected alternative designs to the rocket-driven MX-324 powered by a single 1,150 lb. thrust Westinghouse J30-WE turbojet, the XP-79B was of novel conception and flew on September 12, 1945. However, after flying for 15 min., the pilot lost control and the aircraft was destroyed.

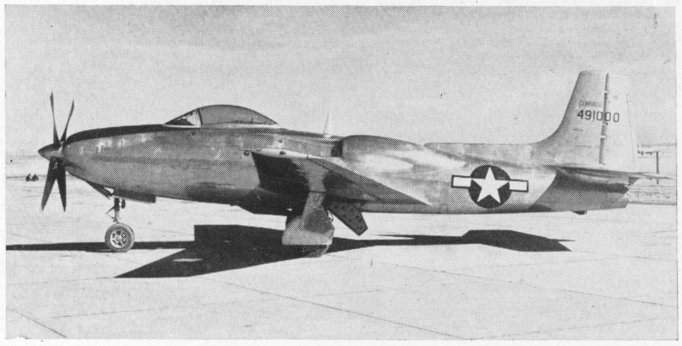
Of welded all-magnesium construction, the XP-79B was powered by two 1,150 lb. thrust Westinghouse J30-WE turbojets, and its pilot lay prone, enabling him to withstand more abrupt manœuvring and up to 12 G. The XP-79B was intended to ram enemy aircraft, shearing off their tail assemblies with its wing leading edges which were built of heavy magnesium plate to enable them to withstand the ramming blows. A "secondary" armament of four 0·5-in. guns was carried.

The XP-79B weighed 8,670 lb. loaded and had a span and length of 38 ft. and 14 ft. respectively. An unusual feature of the control system was the use of air-bellows type rudders for directional control, the air flowing through oval-shaped ducts at each wing-tip and being regulated by a shut-off valve for manœuvring. Two vertical fins were mounted on the jet centre lines to provide directional stability, although a single vertical surface was planned. A retractable four-wheel undercarriage was fitted, and the pilot lay in the thickened wing centre section. Estimated maximum speed was 510 m.p.h.

Intended for ramming attacks and having a prone-positioned pilot, the XP–79B was destroyed on the first test flight.







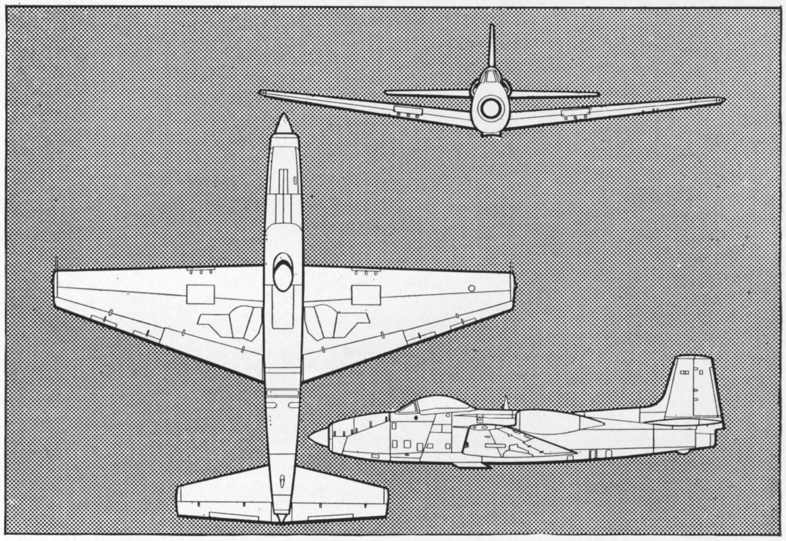
Developed from the piston-cum-jet XP–81, the YP–81 was the first combat aircraft to have both turboprop and turbojet.

CONVAIR YP–81 (DECEMBER) 1945

The first combat aircraft to employ both turboprop and turbojet, the YP–81, was designed to meet U.S.A.F. requirements for a long-range patrol and escort fighter. The YP–81 overcame the range limitations of jet fighters current at the time of its appearance by using a turboprop for cruising flight and the additional power of a turbojet for take-off and combat boost, and flew for the first time on December 21, 1945.

The YP–81 was generally similar to the XP–81, which first flew on February 2, 1945, apart from the Packard-built Rolls-Royce Merlin piston engine, used by the earlier prototype. The YP–81 had a General Electric XT31–GE–3 turboprop in the nose, driving a four-blade airscrew. The turboprop provided 2,300 e.h.p. plus 600 lb. residual thrust, and this power was augmented by an Allison-built General Electric J33–GE–5 turbojet of 4,000 lb. thrust fed by "saddle"-type air intakes.

While this power-plant combination made possible a range of 2,500 miles cruising at 275 m.p.h. at 25,000 ft., the YP–81 was extremely heavy—normal and maximum loaded weights being 19,500 lb. and 24,650 lb. respectively—and maximum speed on the combined power of the two engines was only 484 m.p.h. at sea level and 515 m.p.h. at 30,000 ft., and initial climb rate was 5,300 ft./min. This offered insufficient improvement over contemporary piston-engined escort fighters and an order for thirteen P–81 fighters was cancelled. The overall dimensions of the YP–81 were: span, 50 ft. 6 in.; length, 44 ft. 8 in.; height, 13 ft. 6 in.; gross wing area, 425 sq. ft.

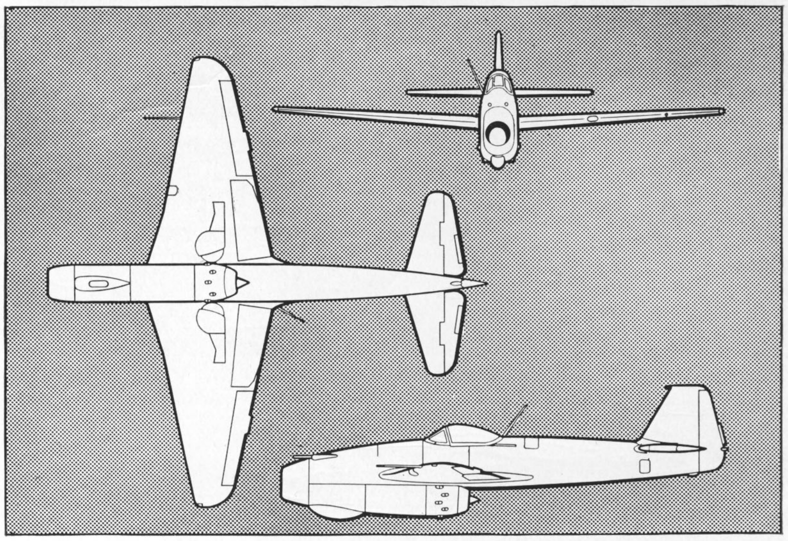


YAK–15/17 (FEATHER) (LATE) 1945

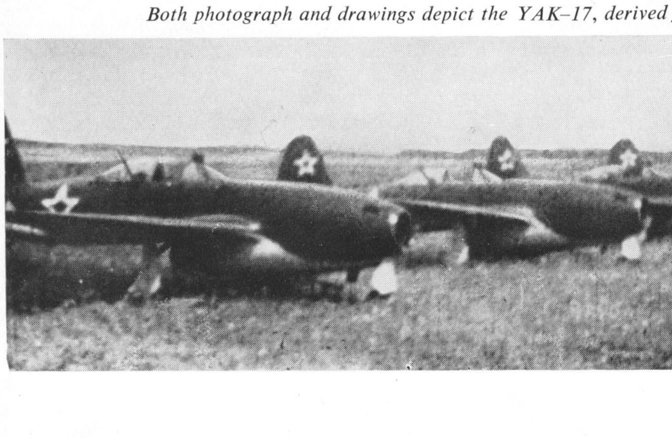
The earliest Soviet-designed jet fighter, the YAK-15 exemplifies the haste with which the Soviet aircraft industry attempted to make use of the German turbojets which fell into its hands during the war's closing stages. The YAK-15 would seem to have commenced life during the closing months of 1945 as an adaptation of a YAK-9 piston-engined fighter airframe to take a Junkers Jumo 004B turbojet of 1,980 lb. thrust. The turbojet was attached to the fuselage below the wing main spar, being fed via a circular intake in the nose and exhausting beneath the wing trailing edge, the rear fuselage being protected from the jet stream by an alloy "bath".

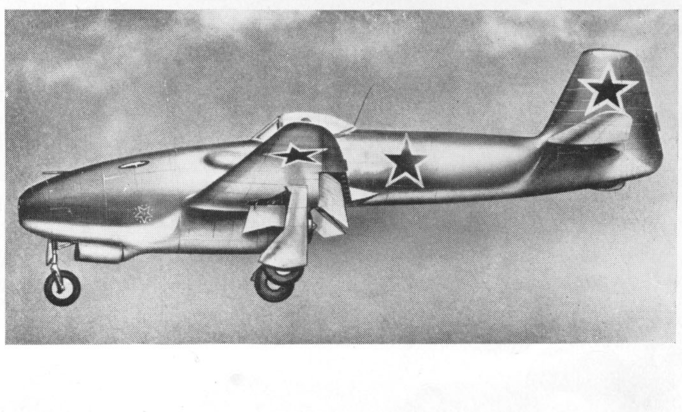
In this crude form, retaining the original tailwheel undercarriage, this aircraft was placed in limited production as the YAK-15 and is known to have entered squadron service in 1946. Several improved versions were developed, the first of these being the YAK-17 tandem two-seat conversion trainer in which the pupil was seated in a second cockpit ahead of the original pilot's cockpit. The change in c.g. position necessitated a nosewheel undercarriage, the main members being transferred to the rear spar and the nosewheel retracting into a bulged housing. The vertical tail surfaces were also redesigned.

The success of this adaptation prompted the development of a single-seat fighter version which retained the nosewheel undercarriage and the new tail assembly. Assuming that the Russian production version of the Jumo 004B turbojet provided some 2,000 lb. thrust, the YAK-17 (Feather) fighter probably attained a maximum speed of 520 m.p.h. Span and length were approximately 31 ft. and 29 ft. 10 in. respectively.



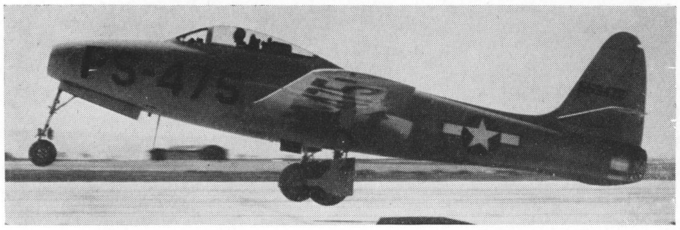
Both photograph and drawings depict the YAK–17, derived from the YAK–15 and dubbed "Feather" by N.A.T.O. forces.



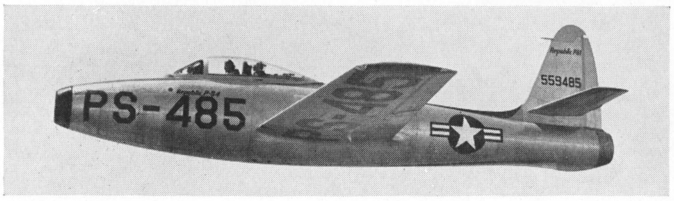


REPUBLIC F-84 THUNDERJET

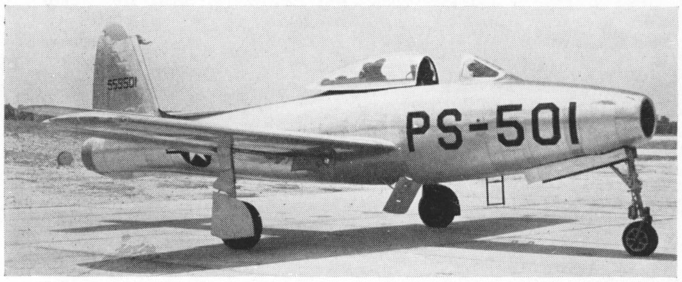
(FEBRUARY) 1946



(Above) *The prototype Thunderjet, the XP–84 (45–59475).*

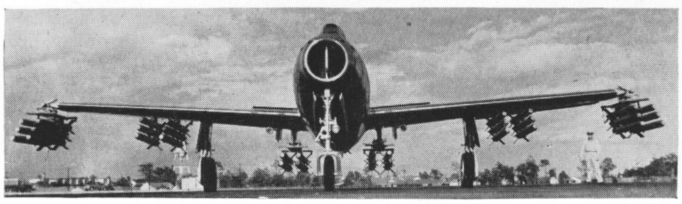


(Above) *YP–84–5–RE (45–59485), fifth service test Thunderjet.*



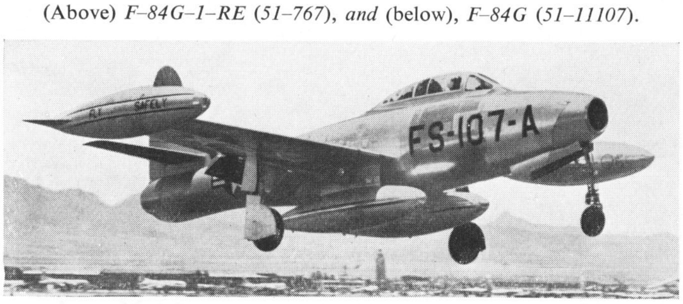
(Above) *An F–84B–1–RE (45–59501) of the initial production batch.*

(Above) *An F–84D (48–679) with reinforced wing.*



(Above) *F–84E Thunderjet with thirty-two 5-in HVAR.*

(Above) *F–84G–1–RE (51–767), and* (below), *F–84G (51–11107).*



In the summer of 1944 Republic Aviation commenced to investigate the possibility of adapting the piston-engined F–47 Thunderbolt for jet propulsion by installing an axial-flow turbojet in the lower part of the fighter's rotund fuselage. By November it had been decided to abandon the proposed conversion of the existing aircraft and design a completely new airframe around the new General Electric J35 axial engine. Embodying a slender fuselage with a simple nose air intake to take maximum advantage of the straight-through airflow principle of the axial-flow turbojet, the first prototype, designated XP–84 Thunderjet, was completed in December 1945 and flown for the first time on February 28, 1946. The second XP–84 was completed in August 1946, and one month later, on September 7, established a U.S. speed record of 611 m.p.h.

The low mid-wing of the Thunderjet had an aspect ratio of 5·10, which was a compromise between a lower value for reduced drag and a higher value for long range, and a 12% constant section. The design wing loading was 50 lb./sq. ft. The fuselage was of exceptionally clean design and possessed a comparatively high fineness ratio. A simple circular nose intake divided either side of the nosewheel bay, contracting aft of the cockpit to feed the J35 which exhausted through a long fuselage duct. This arrangement limited fuselage capacity for fuel stowage, but had the advantage of providing low-drag contours. The low fuselage fuel capacity was partly compensated for by the relatively thick wing section (necessitated by the need to position the main wheel wells in the wing) which allowed for the inclusion of considerable wing tankage.

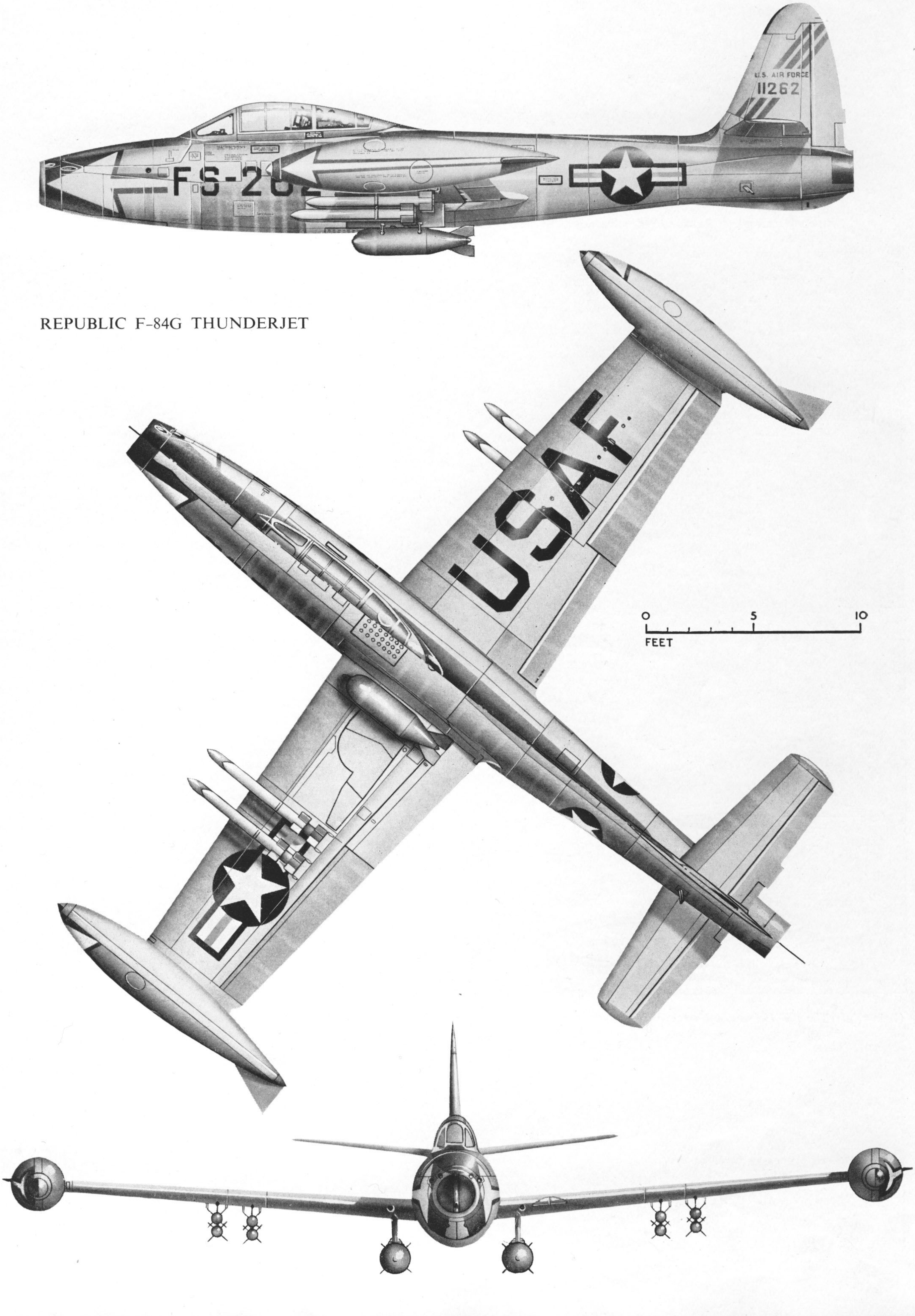
Both XP–84 prototypes were powered by the 3,750 lb. thrust General Electric J35–GE–7 turbojet, and the thirteen preproduction YP–84 Thunderjets differed primarily in having the more powerful 4,000 lb. thrust Allison J35–A–15 and an armament of six 0·5-in. M2 guns. The first production model, the F–84B, had an ejector seat for the pilot, higher fire-rate M3 guns (1,200 r.p.m. as compared to 850 r.p.m.) and retractable rocket-launching racks. Five hundred F–84Bs were produced for the U.S.A.F., and this model had a maximum speed of 598 m.p.h. at sea level and an initial climb rate of 5,800 ft./min. Empty and loaded weights were 9,155 lb. and 15,800 lb. respectively.

Progressive development resulted in the F–84C with improved bomb-release mechanism incorporating sequence control and a J35–A–13 turbojet. Only 191 machines of an order for 409 F–84Cs had been completed when a reinforced wing, winterised fuel system and hinged gun deck introduced the F–84D, 318 of which were built. With the availability of the 5,000 lb. thrust J35–A–17 turbojet, the Thunderjet was adapted to take the considerable increase in power, resulting in the F–84E model. Fuselage length was increased 15 in., wing-tip tanks were fitted with fins to permit full manœuvrability with tanks in position, structural modifications were made to increase permissible G loads, and the addition of two 191·5 Imp. gal. tanks on bomb shackles beneath the wing, inboard of the undercarriage main members, increased combat radius from 850 to 1,000 miles. Empty and loaded weights were increased to 11,000 lb. and 16,685 lb. respectively, and with two JATO bottles to assist take-off, an overload weight of 24,000 lb. was permissible.

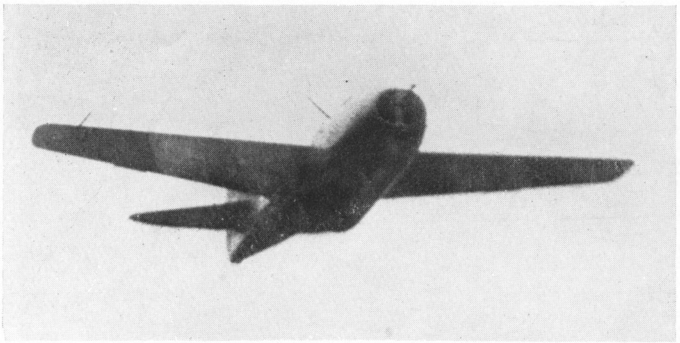
After the completion of 120 F–84E Thunderjets, production continued with the F–84G (the F84F swept-wing development was developed concurrently with the F–84G and is described on page 114), powered by the 5,600 lb. thrust J35–A–29 turbojet. The F–84G continued in production until July 1953, when a total of 4,457 Thunderjets had been completed. The F–84G was fitted with in-flight refuelling equipment with receptacle in the port wing for use with the Boeing flying-boom system. Under test an F–84G remained aloft for 12 hr. 5 min., receiving four aerial refuellings during the flight.

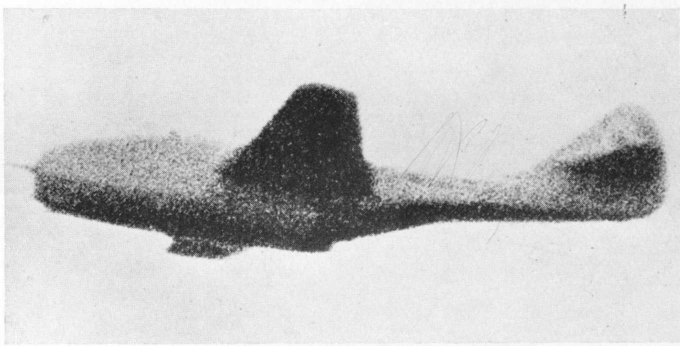
The F–84G has an empty weight of 11,460 lb. and a normal loaded weight of 18,000 lb. Maximum speed is 605 m.p.h. at sea level, and combat radius is 850 miles, and 1,000 miles with two additional 191·5 Imp.-gal. tanks under the wing. Alternative underwing loads include thirty-two 5-in. HVAR, or two 11·5-in. and sixteen 5-in. rocket projectiles. The F–84G was the first U.S.A.F. fighter-bomber announced as being capable of carrying tactical atomic weapons. Overall dimensions are: span, 36 ft. 4 in.; length, 38 ft. 5 in.; height, 12 ft. 10¼ in.

The F–84G currently serves with the air forces of the U.S.A., France, Italy, Netherlands, Belgium, Denmark, Norway, Turkey, Portugal, Nationalist China and Yugoslavia.

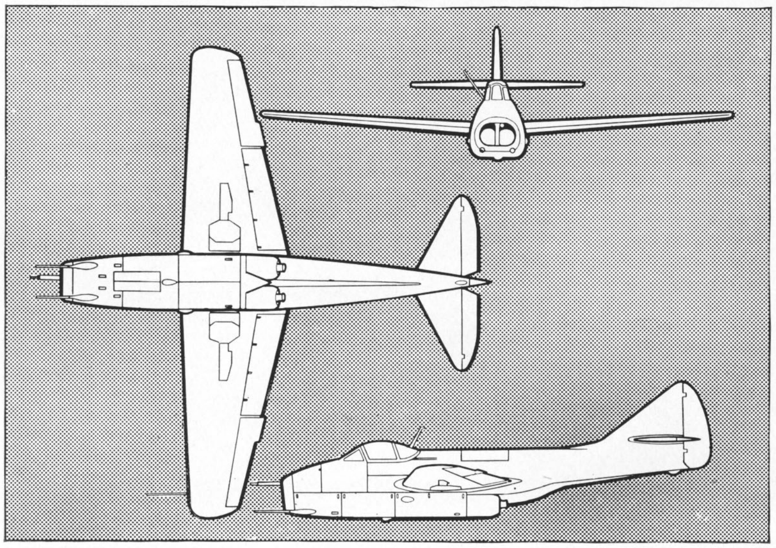


REPUBLIC F-84G THUNDERJET





An early example of Russian jet-fighter design, the MIG–9 employed two turbojets as no single engine of sufficient power was available.

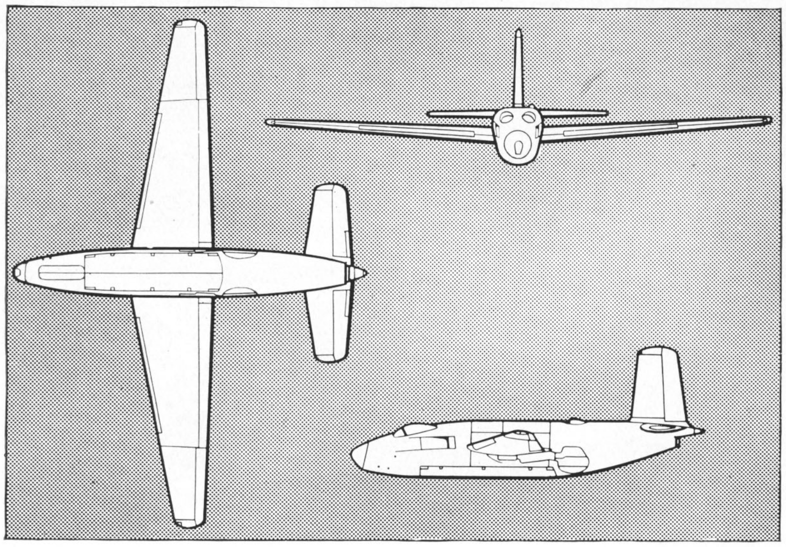


MIG–9 (EARLY) 1946

The MIG–9 s one of the earliest examples of Russian jet-fighter design, and the first twin-turbojet aircraft to be employed by the Soviet Air Force. Designed by Artem I. Mikoyan and Mikhail I. Gurevich, the MIG–9 was publicly demonstrated in 1947, and it can be assumed, therefore, that this type was first flown early in 1946, the prototype probably being powered by two captured Junkers Jumo 004B turbojets.

A twin-jet fighter affords a considerably greater safety margin than a single-jet machine, but the choice of twin-jet layout for a small single-seat interceptor such as the MIG–9 would seem to have been dictated by Russia's lack of a turbojet of sufficient power to afford the desired performance. The side-by-side disposition of the turbojets below the wing and the short jet pipes exhausting under the rear fuselage suggest German design influence. This layout has the advantage of enabling the fighter to fly efficiently on the power of one turbojet to protract endurance, both units being mounted close to the fuselage centre line. The short jet pipes were dictated by the need to eliminate thrust losses—which increase with every foot of tailpipe length—and heavy gauge metal shroud plates were provided to protect the rear fuselage from the jet stream.

Apart from its power plant, the MIG–9 displayed a further departure from previous Soviet aircraft-design technique in having a nosewheel undercarriage. Production MIG–9 fighters were powered by Russian-built versions of the Jumo 004B, with which estimated maximum speed was 595 m.p.h. Approximate dimensions were: span, 34 ft.; length, 32 ft. 9 in.



DOUGLAS XB–43 (MAY) 1946

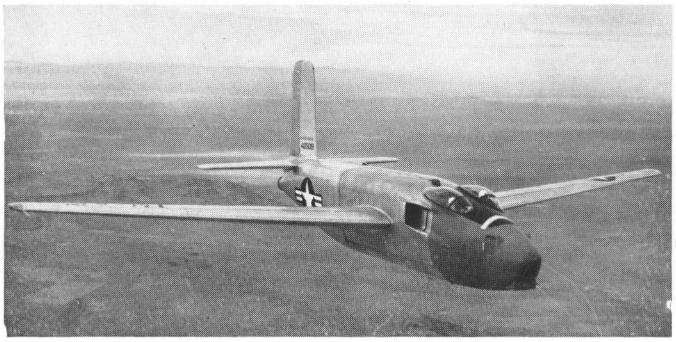
The first U.S. light jet bomber, the Douglas XB-43, flew for the first time in May 1946 and was powered by two 3,750 lb. thrust General Electric J35-GE-3 turbojets completely buried in the deep fuselage, fed via box-shaped lateral intakes and exhausting at the tail. The XB-43 was derived from the piston-engined XB-42 and displayed several unusual features. Individual cockpit canopies were provided for the two side-by-side-seated crew members, and the method of undercarriage retraction was novel, the main members retracting backwards into fuselage housings, freeing the laminar-flow wing of wheel-wells.

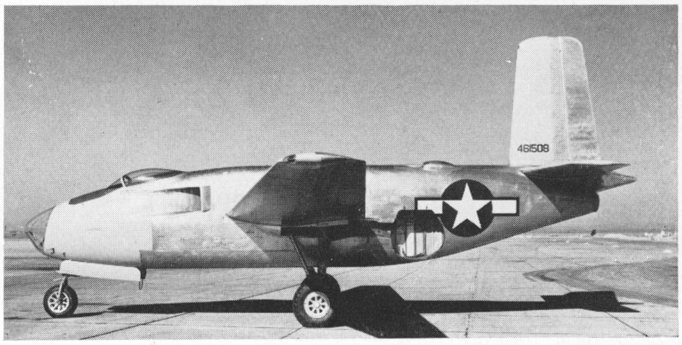
Two prototypes were completed, the second being designated YB-43, and a maximum speed of 507 m.p.h. and a ceiling of 38,000 ft. were attained. Maximum range was 1,400 miles, and loaded weight was 35,000 lb.

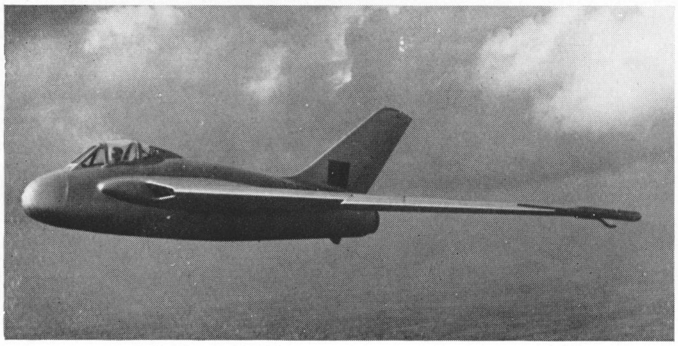
The XB-43 met the estimated performance, but proved to be unstable under certain conditions, and no production orders were placed by the U.S.A.F. However, in 1948 the second prototype, the YB-43, was adopted by the U.S.A.F. Flight Test Centre as an engine test-bed, being finally retired late in 1953. The YB-43 usually flew with another engine, such as a J47, supplanting one of its two J35s to obtain such data as the minimum safe lubricating-oil flow. It was also employed on tests concerning the development of pressurised oil tanks and high-altitude starting equipment.

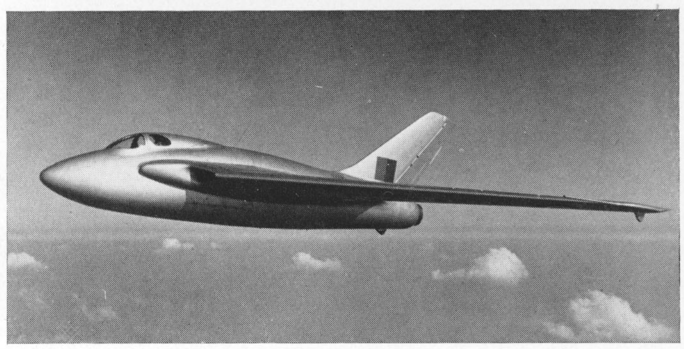
The overall dimensions of the XB-43 and YB-43 were: span, 71 ft. 2 in.; length, 51 ft. 5 in.; height, 24 ft. 3 in.

(Below, left) *The YB–43 (44–61509) was employed as an engine test-bed. The XB–43 (44–61508)* (below, right, and drawing) *was the first U.S. jet bomber.*



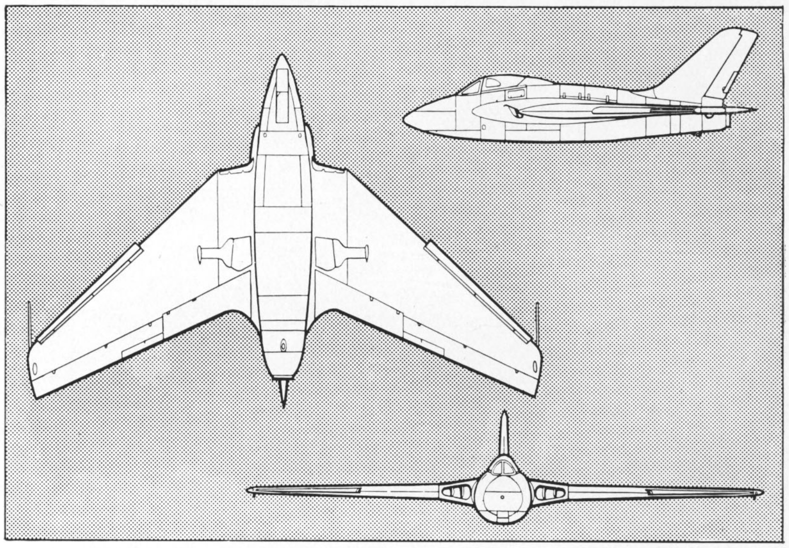






The first D.H.108 research monoplane, TG283 (above, left), *and the third D.H.108, VW120* (above, right, and g.a. drawing).

DE HAVILLAND D.H.108 (MAY) 1946



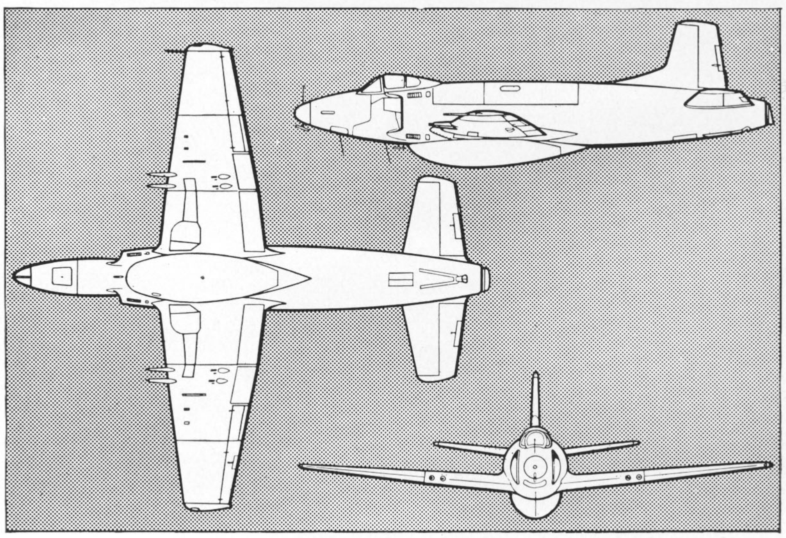
The D.H.108 was designed and built primarily for the exploration of control and stability problems in swept-wing aircraft. The first of three D.H.108 research aircraft featured the fuselage of a standard Vampire fighter and was powered by a 3,000 lb. thrust de Havilland Goblin 2 turbojet. Flown for the first time on May 15, 1946, the D.H.108 had a 39-ft.-span wing swept at 43° and carrying fixed open slots on the leading edge which limited speed to 350 m.p.h. Overall length was 24 ft. 6 in.

While the first machine had been built to determine the low-speed characteristics of the wing, the second D.H.108 was built to assess its high-speed characteristics. Accordingly, retractable wing-slots were fitted and a 3,500 lb. thrust Goblin 4 turbojet was employed. The third prototype, powered by a 3,600 lb. thrust Goblin 5, was built to continue the high-speed programme initiated with the second D.H.108, and incorporated a number of structural changes, including a lengthened fuselage nose and a redesigned cockpit canopy. Automatic leading-edge slots, powered controls and an ejector seat were installed.

With this aircraft an International Speed Record over a 100-km. closed circuit of 605·23 m.p.h. was established on April 12, 1948, and in the same year, on September 6, the third D.H.108 became the first British aircraft to exceed the speed of sound, a Mach number of approximately 1·02 being recorded in a dive from 40,000 ft. to 30,000 ft.

The D.H.108 was of mixed construction. Lateral and longitudinal control were effected by means of elevons, and flaps were fitted to the wing trailing edges.

SUPERMARINE ATTACKER (JULY) 1946

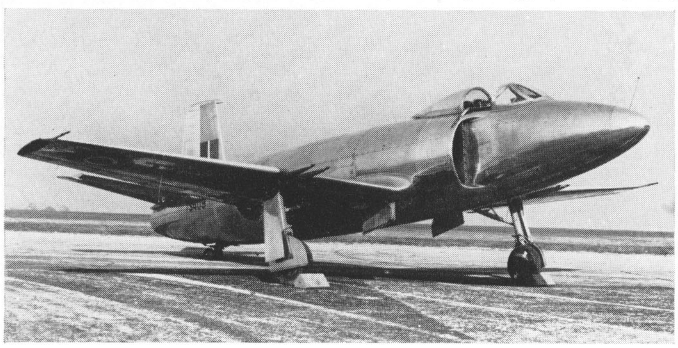


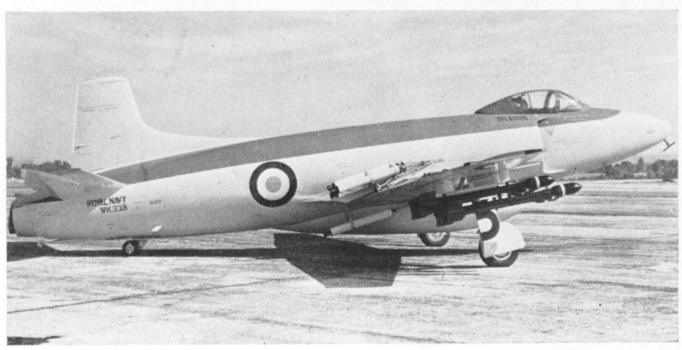
The Attacker was developed to specification E.10/44, which called for a single-seat fighter powered by a Rolls-Royce Nene turbojet and employing the laminar-flow wing used by the earlier piston-engined Spiteful fighter. Early in 1945, a complimentary specification, E.1/45, was issued, calling for a deck-landing version, and work was commenced on three prototypes, the second and third having naval equipment and deck arrester gear. The first prototype, the Type 392, flew on July 27, 1946, and the first naval prototype, Type 398, followed on June 17, 1947, the latter differing in having lengthened undercarriage stroke, lift spoilers and deck arrester hook. The third prototype had the wing positioned 1 ft. 1½ in. further back, and wider air intakes.

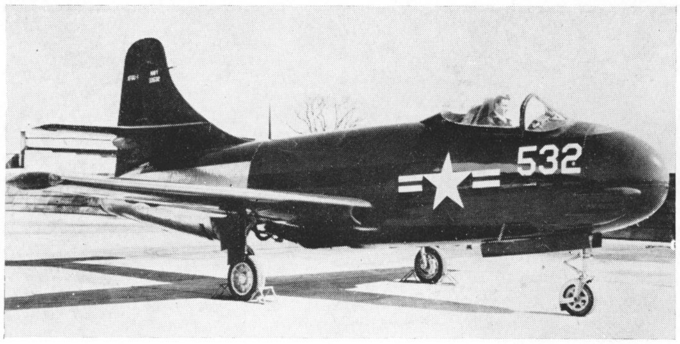
No orders for the land-based version were placed by the R.A.F., but, as the Attacker, production orders were placed by the British Navy in November 1949, the first production Attacker flying on April 4, 1950. The first service versions were the Attacker F.1 and F.B.1, powered by the 5,100 lb. thrust Nene 3, the latter carrying underwing ordnance. These were followed by the F.B.2 with the Nene 102 and a metal-framed cockpit canopy. Thirty-six land-based Type 538 Attackers were delivered to the Pakistani Air Force, and 145 were built for the Navy.

The Attacker F.B.2 weighs 9,910 lb. empty and 17,350 lb. (maximum) loaded. Maximum speed is 590 m.p.h. at sea level, and initial climb rate (11,500 lb.) is 6,350 ft./min. Dimensions are: span, 36 ft. 11 in.; length, 37 ft. 6 in.; height, 9 ft. 11 in.; wing area, 226·4 sq. ft.

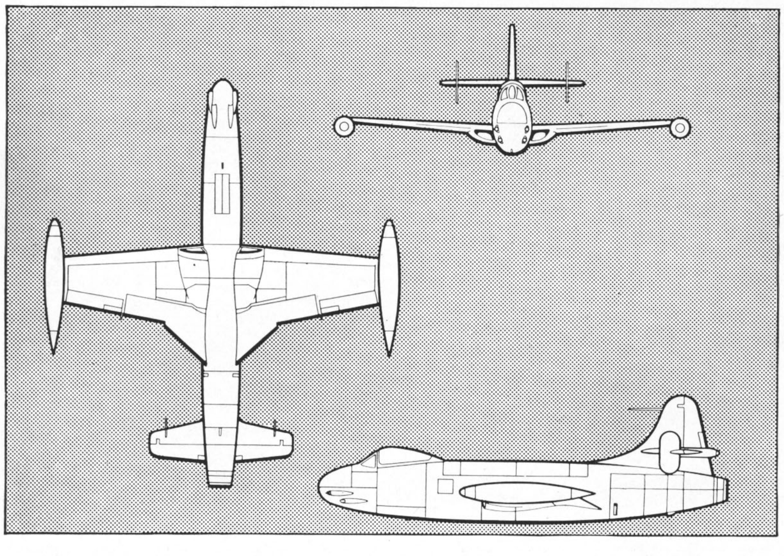
(Below, left) *The Type 392 Attacker prototype, TS409, and* (below, right, and g.a. drawing) *the Attacker F.B.2 (WK338).*







(Above, left) *The first XF6U–1 with afterburner extension, and* (right) *the third XF6U–1. The drawing depicts the production F6U–1.*

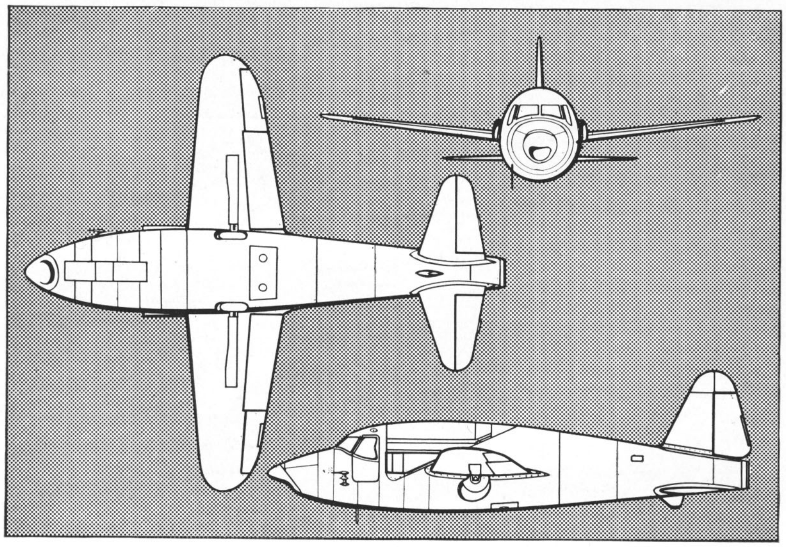


CHANCE VOUGHT F6U–1 (OCTOBER) 1946

The F6U–1 Pirate was a compact single-seat carrier-borne fighter, the prototype of which, the XF6U–1, was flown for the first time on October 2, 1946. The three XF6U–1 prototypes were powered by the 3,000 lb. thrust Westinghouse J34–WE–22 turbojet fed via wing-root intakes and exhausting below the tail cone. This power plant was later replaced by the J34–WE–30A, which was fitted with a Solar afterburner in a lengthened rear fuselage and gave a total thrust of 4,200 lb. The first of thirty similarly powered F6U–1 fighters flew in July 1949, and the last was delivered in February 1950.

The F6U–1 Pirate differed from the original XF6U–1 prototype in a number of respects: wing area was increased by the addition of large fillets fitted to the wing trailing edge at approximately quarter/span, and vertical tail surface area was increased by the addition of a large dorsal fillet and small auxiliary fins mounted near to the tailplane tips. An armament of four 20-mm. guns was installed in the fuselage nose, and normal loaded weight was 11,300 lb. Maximum level speed with afterburning was 555 m.p.h., and range (internal fuel only) was 750 miles. This could be extended to more than 1,000 miles with jettisonable wing-tip tanks.

The Pirate made extensive use of Metalite skinning in its construction—a material developed by the Chance Vought company and comprising two sheets of high-strength aluminium alloy bonded to a balsa-wood core—which eliminated skin-wrinkling and made possible a saving in structural weight, as fewer ribs and stiffeners were necessary. Overall dimensions were: span, 32 ft. 10 in.; length, 37 ft. 7 in.; height, 12 ft. 11 in.



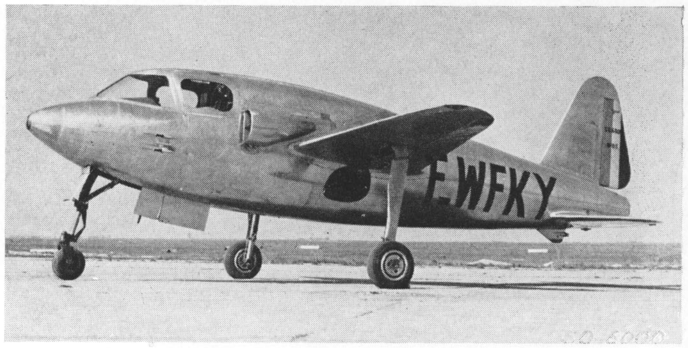
SUD-OUEST S.O.6000 (NOVEMBER) 1946

The first jet-propelled aircraft of French design to be flown, the S.O.6000 Triton was developed clandestinely during the German occupation of France, design work being initiated in 1943 and construction commencing in 1945. The Triton was initially conceived as a flight test-bed for the 3,250 lb. thrust Rateau SRA-1 turbojet, but the design was revised as a side-by-side two-seat trainer at an early stage, the first prototype flying on November 11, 1946, on the power of a 1,980 lb. thrust Junkers Jumo 004B-2 turbojet.

Characterised by an extremely large, oval-section fuselage, in comparison with which the wing appeared excessively small, the Triton could be adapted for a variety of turbojets. It was proposed to power the four additional prototypes ordered by the 3,500 lb. thrust Rolls-Royce Derwent 5, but the Hispano-Suiza Nene 101 of 4,850 lb. thrust was eventually standardised, the installation of this engine necessitating considerable revision of the air-intake ducting. The Jumo-powered first prototype employed a "shark's mouth" type intake in the fuselage nose, and the first Nene-powered Triton, the S.O.6000-04, which first flew on March 19, 1948, had additional lateral intakes aft of the cabin. These intakes were retained by the second (S.O.6000-03) and subsequent Nene-powered prototypes which dispensed with the nose intake.

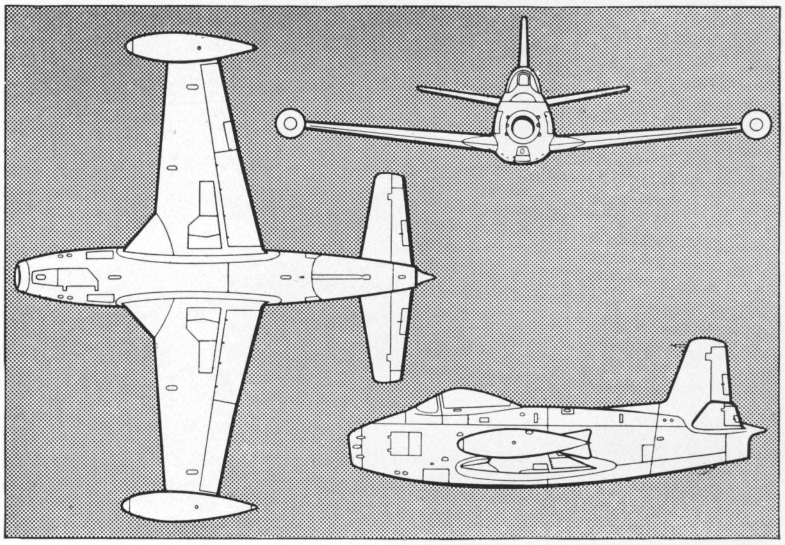
The S.O.6000-04 had a maximum speed of 593 m.p.h. at sea level and a cruising speed of 534 m.p.h. at 32,800 ft. Initial climb rate was 9,840 ft./min., and ceiling was 39,360 ft. Empty and loaded weights were 7,050 lb. and 10,032 lb. Dimensions: span, 32 ft. 8 in.; length, 34 ft. 2 in.; wing area, 161·4 sq. ft.

(Below, left, and g.a. drawing) *The S.O.6000–04 Triton, and* (below, right) *the S.O.6000–03.*



The FJ–1 Fury's chief claim to distinction is as the progenitor of the F–86 Sabre fighter series.

NORTH AMERICAN FJ–1 FURY (NOVEMBER) 1946

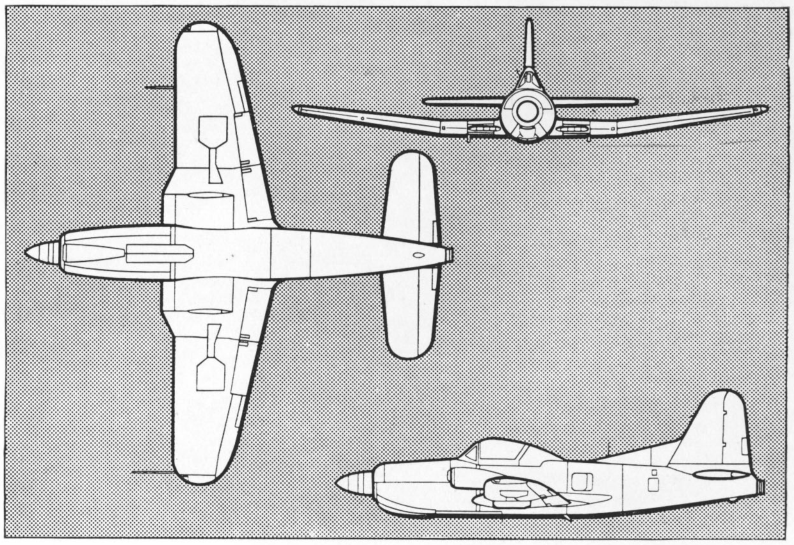


The FJ–1 Fury is particularly worthy of note as the progenitor of the entire F–86 Sabre fighter series, and was the result of several design studies for a single-seat carrier-borne interceptor submitted to the U.S. Navy in 1944. A contract for three XFJ–1 (N.A.134) prototypes was placed in January 1945, and one hundred FJ–1 (N.A.141) production aircraft were ordered on May 18, 1945. Simultaneously, three prototypes of a land-based version stripped of all naval gear were ordered by the U.S.A.F. under the designation XF–86.

The first XFJ–1 flew on November 27, 1946, powered by a 4,000 lb. thrust Allison J35–A–5 turbojet. This aircraft attained a Mach number of 0·87 early in 1947, the highest attained by any U.S. fighter at that time. Orders for the production model were cut back to thirty machines and, as the FJ–1 Fury, the first of these was delivered to the U.S. Navy in 1947, differing from the prototypes in having leading-edge wing-root extensions. The land-based version, the XF–86, was designed to attain a top speed of 582 m.p.h. at 45,000 ft., but this performance fell short of U.S.A.F. requirements, resulting in drastic re-design which removed all similarity to the Fury.

The FJ–1 Fury had a maximum speed of 568 m.p.h. and an initial climb rate of 5,120 ft./min. Range on internal fuel only (383 Imp. gal) was some 970 miles, but this could be extended to 1,550 miles by the attachment of two jettisonable wing-tip fuel tanks each containing 141·5 Imp. gal. Loaded weight was 12,697 lb.; armament comprised six 0·5-in. guns; and span and length were 38 ft. 1½ in. and 33 ft. 8 in.

RYAN XF2R–1 (NOVEMBER) 1946

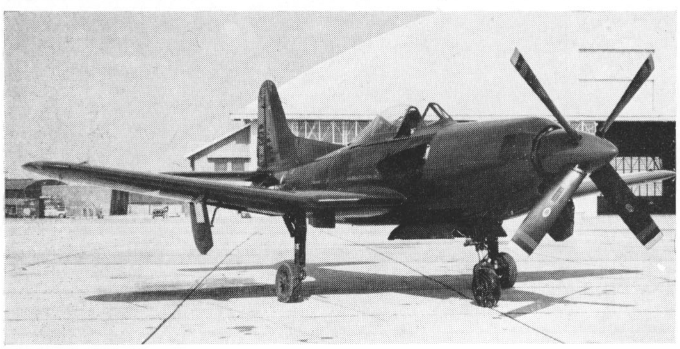


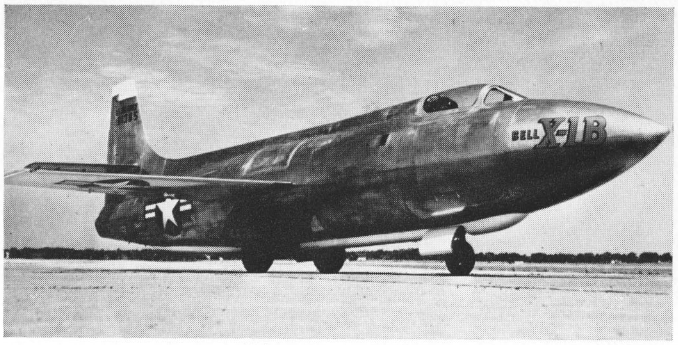
The Ryan Model 29, or XF2R–1 single-seat experimental fighter, was derived from the Ryan Model 28 Fireball, or FR–1, of which sixty-five examples were built. Whereas the FR–1 employed a piston engine in the nose for cruising flight and one 1,600 lb. thrust General Electric J31–GE–3 turbojet in the rear fuselage the XF2R–1 had the piston engine replaced by a General Electric XT31–GE–2 turboprop.

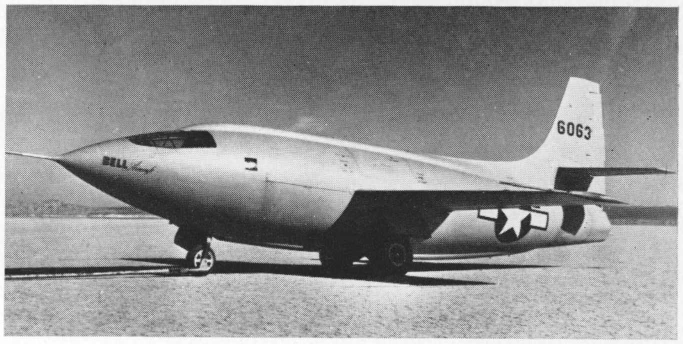
While the wing of the FR–1 was retained, the installation of the turboprop resulted in some increase in fuselage length and an increase in the area of the vertical tail surfaces necessitated by the increased torque from the large, four-blade airscrew. A J31–GE turbojet of 2,000 lb. thrust was substituted for the lower powered unit of the FR–1, and the XT31–GE–2 turboprop developed 2,300 s.h.p. and 600 lb. residual thrust. The XF2R–1 was flown for the first time in November 1946, and during an early flight test attained an altitude of 39,100 ft.—an unofficial record for turboprop-powered aircraft at that time.

For cruising flight it was proposed that the XF2R–1 should fly on the power of the turboprop alone, the turbojet being used for combat boost. Maximum level speed at sea level using both engines was approximately 500 m.p.h. An altitude of 10,000 ft. could be attained in two minutes and 39,100 ft. in 23 min. Loaded weight was 11,000 lb.; and overall dimensions included a span of 40 ft., a length of 36 ft., a height of 14 ft., and a wing area of 275 sq. ft. The wing of the XF2R–1 embodied hydraulic folding mechanism for carrier stowage, and, when folded, the span was 17 ft. 6 in.

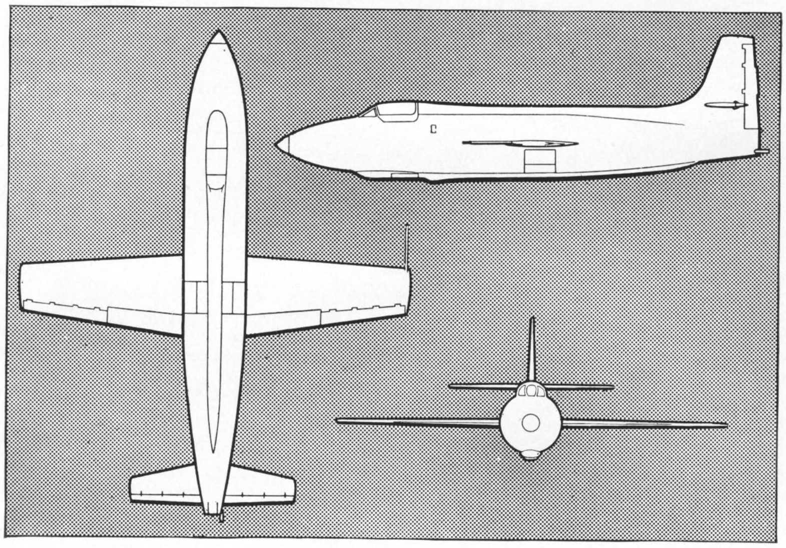
The XF2R–1, derived from the FR–1 Fireball, was the world's first turboprop-driven naval fighter.







(Above, left) *The Bell X–1B,* (right) *the Bell X–1, and* (general arrangement drawing) *the Bell X–1A.*



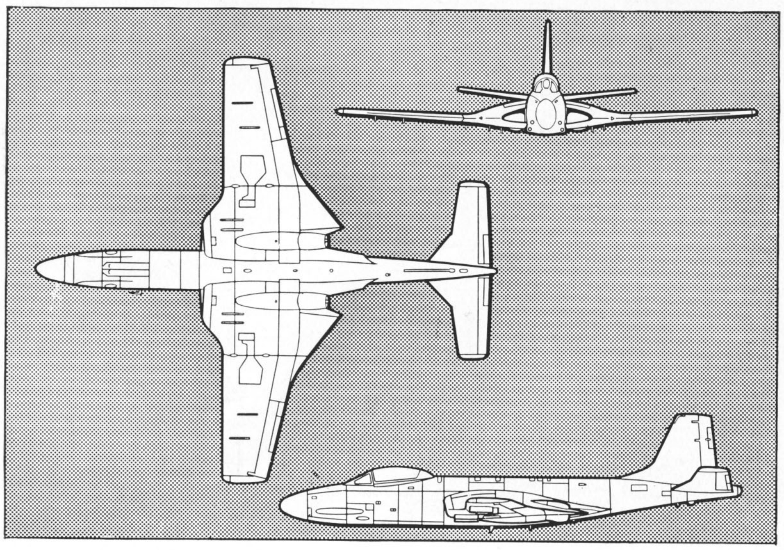
BELL X–1 (DECEMBER) 1946

Designed to investigate supersonic flight problems, the Bell X–1 made its first powered flight on December 9, 1946, after being launched in the air. Powered by a Reaction Motors XLR–11–RM–5 comprising four separate 1,500 lb. thrust rockets which could be fired singly or in concert, the X–1 became the first piloted aircraft to exceed Mach unity when, on October 14, 1947, it attained Mach 1·46 (967 m.p.h.) at 70,140 ft.

Owing to delays in the development of the intended turbine fuel-pump system, the X–1 used nitrogen-pressure fuel feed, and the 2·5-min. full-thrust duration was insufficient to enable it to attain the designed speed of 1,700 m.p.h. at 80,000 ft. The X–1 carried a fuel load of 5,100 lb. and weighed 13,400 lb. fully loaded. Overall dimensions were: span, 28 ft.; length, 31 ft.; height 10 ft. 8 in. Three X–1 aircraft were built.

A modified model, the Bell X–1A, differed from the earlier X–1 in having a stepped canopy replacing the flush-type windshield, a 4 ft. 7 in. increase in fuselage length to accommodate tanks for a further 5,900 lb. fuel, and a turbo-pump fuel system for the rocket motor. Full-power endurance was increased to 4·2 min. and loaded weight to 18,000 lb. With fuel expended weight was 7,000 lb., and, with undercarriage and flaps down, stalling speed was 150 m.p.h. The X–1A attained Mach 2·5 (1,650 m.p.h.) at 70,000 ft. on December 16, 1953, and has since set a new altitude record of 90,000 ft.

A further development, the X–1B, is intended to investigate thermal problems. The X–1C was cancelled and the X–1D was destroyed on August 23, 1951, before flight testing could commence.



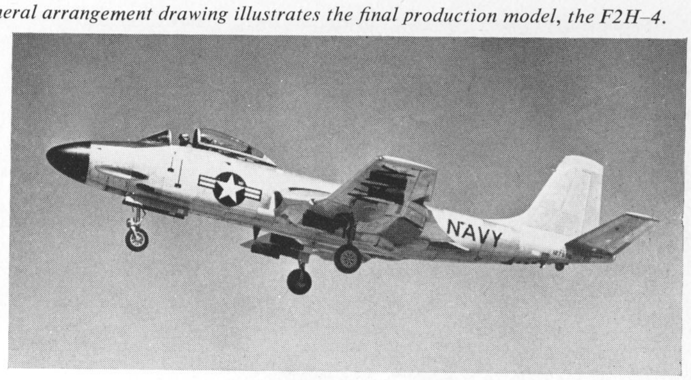
McDONNELL BANSHEE (JANUARY) 1947

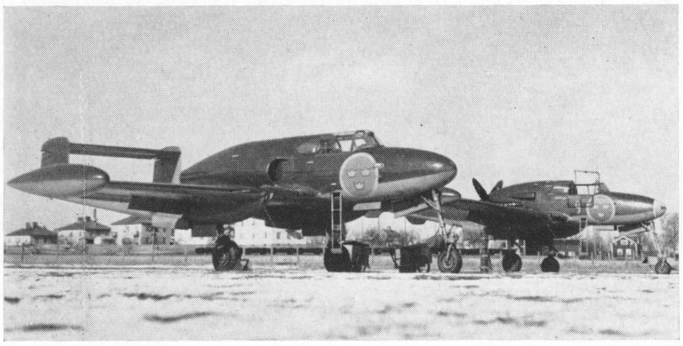
Designed in 1948 as a potential successor to the FH-1 Phantom, the prototype Banshee carrier-borne fighter, the XF2H-1, flew on January 11, 1947, and a production order for fifty-six F2H-1 Banshee fighters was placed in May 1947, the first flying on August 10, 1949. The F2H-1 was powered by two 3,000 lb. thrust Westinghouse J34-WE-22 turbojets. The improved F2H-2 was powered by two 3,250 lb. thrust J34-WE-34 turbojets and had a fuselage lengthened from 38 ft. 11½ in. to 40 ft. 1 in. to accommodate an additional 147 Imp. gal. of fuel. Two non-jettisonable 166·5 Imp. gal. wingtip tanks increased span from 41 ft. 6 in. to 44 ft. 11 in.

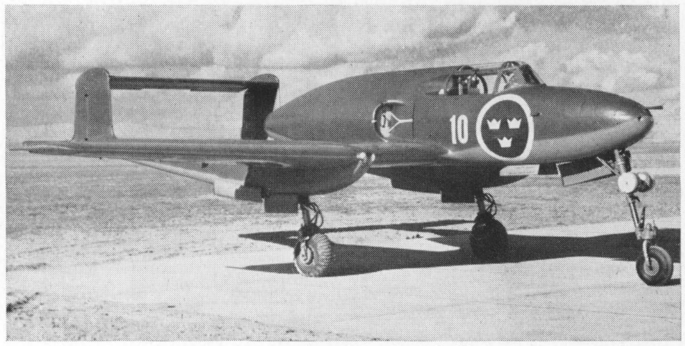
The first of an order for 188 F2H-2 fighters (including fourteen F2H-2N night fighters) was flown in August 1949, and a contract for a further 146 machines was placed in April 1952. Fifty-eight F2H-2P photo-reconnaissance models were built.

The F2H-3 was a long-range all-weather development in which the fuselage length was increased by 2 ft. 7 in. to allow for two additional internal tanks. A total of 175 F2H-3 Banshees powered by two 3,250 lb. thrust J34-WE-34 units was followed by fifty-five externally similar F2H-4 Banshees (J34-WE-38), the last of which was delivered on October 30, 1953. The F2H-4 Banshee had a top speed of 610 m.p.h. at sea level, an initial climb rate of 9,000 ft./min., a service ceiling of 56,000 ft., and a maximum range of some 2,000 miles. Approximate loaded weight was 19,000 lb. and fixed armament comprised four 20-mm. cannon. A retrospective modification on F2H-3 and F2H-4 Banshees (shown on the accompanying drawing) was an increase in tailplane area.

(Below, left) *The XF2H–1 prototype Banshee, and* (right) *the F2H–3. The general arrangement drawing illustrates the final production model, the F2H–4.*

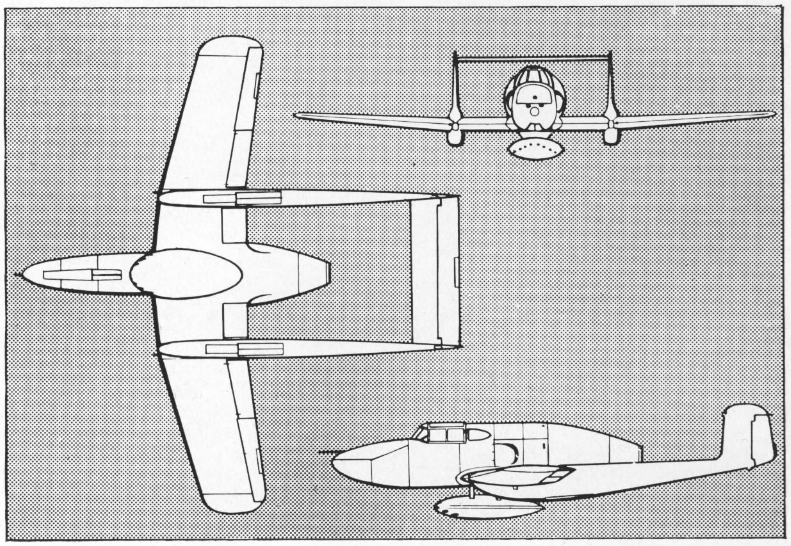






(Above, left) *The SAAB–21RA side by side with its piston-engined predecessor, the SAAB–21A. The drawing shows the detachable eight-gun tray fitted.*

SAAB–21R (MARCH) 1947

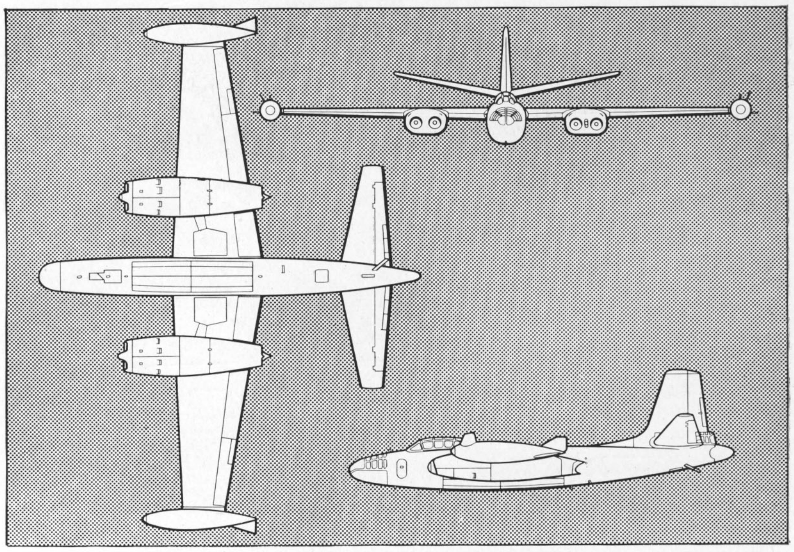


The SAAB-21 single-seat fighter remains unique in having possessed the only airframe in the world to have been fitted with both piston and jet power plants and to have been produced in quantity with both forms of prime mover. The SAAB-21 was initially produced in 1943 with a 1,475 h.p. SFA-built DB 605B piston-engine, and more than 400 were completed as the J 21A and A 21A-3. With the availability of the de Havilland Goblin turbojet, this power plant was substituted for the piston engine formerly fitted, and the first of three Goblin-powered prototypes flew on March 10, 1947.

However, it would be incorrect to consider the SAAB-21R, as the jet version was designated, as merely a SAAB-21A with a turbojet. The Goblin possessed a greater diameter than its predecessor, and it was necessary to redesign the rear fuselage. The air intakes for the turbojet were located at the point of transition from the narrow front fuselage to the wider rear section. The empennage was redesigned, and the change in thrust angle necessitated a modified undercarriage.

Orders were placed for 120 fighters of this type, although only sixty machines were completed, and these were produced in two versions: the SAAB-21RA with the 3,000 lb. thrust de Havilland Goblin D.Gn.2, and the SAAB-21RB with the 3,300 lb. thrust SFA-built Goblin 3. The latter version had a maximum speed of some 520 m.p.h. at sea level, and an initial climb rate of 4,600 ft./min. Armament comprised one 20-mm. cannon and four 13·2-mm. guns, and this could be augmented by a pod containing a further eight guns. Dimensions were: span, 37 ft. 3 in.; length, 33 ft. 2 in.; height, 9 ft. 8 in.

NORTH AMERICAN B–45 TORNADO (MARCH) 1947

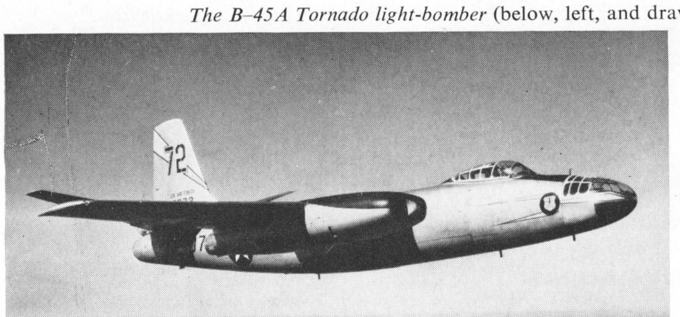


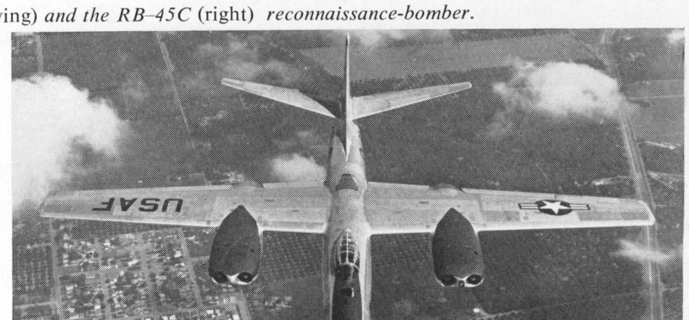
The first of a new class of multi-jet tactical support bombers developed for the U.S.A.F., and the first U.S. four-jet aircraft to fly, the Tornado, which first flew on March 17, 1947, was actually an adaptation of an earlier piston-engined bomber design. The prototype Tornado, the N.A.130 or XB-45, was powered by four 4,000 lb. thrust Allison J35-A-4 turbojets paired in two exceptionally large underslung nacelles. These were replaced by the General Electric J47-GE-9 of similar power in the first production model, the B-45A, ninety-six of which were built for U.S.A.F. bomber squadrons. The B-45A was succeeded on the production line by a progressive development, the B-45C powered by two 5,200 lb. thrust J47-GE-13s and two J47–GE–15s, the latter units having water injection increasing thrust to 6,000 lb. Ten B-45C bombers and thirty-three RB-45C reconnaissance bombers were produced. The RB-45C possessed a modified nose section containing five camera stations.

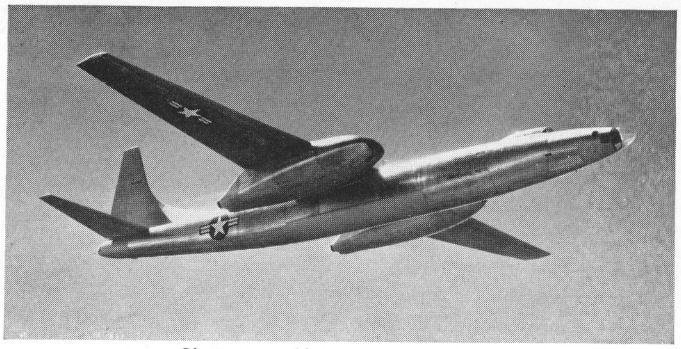
The B-45C carried a crew of three and a maximum bomb load of 20,000 lb. Sole defensive armament comprised two 0·50-in. guns in a tail position. Approximate loaded weight was 82,600 lb., maximum speed was 550 m.p.h. at sea level, service ceiling was 40,000 ft., and combat radius was 1,200 miles. Overall dimensions were: span, 89 ft. 6 in.; length, 74 ft.; height, 25 ft.

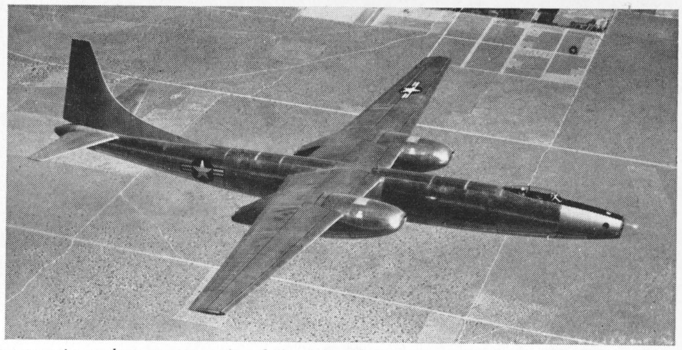
The Tornado represented an interim stage in U.S. bomber design, being of orthodox airscrew-type layout. A number of B-45A Tornadoes have been modified as high-speed target tugs, towing the 20-ft.-span Chance-Vought all-metal target glider, and others have been adapted for use as engine test-beds.

The B–45A Tornado light-bomber (below, left, and drawing) *and the RB–45C* (right) *reconnaissance-bomber.*

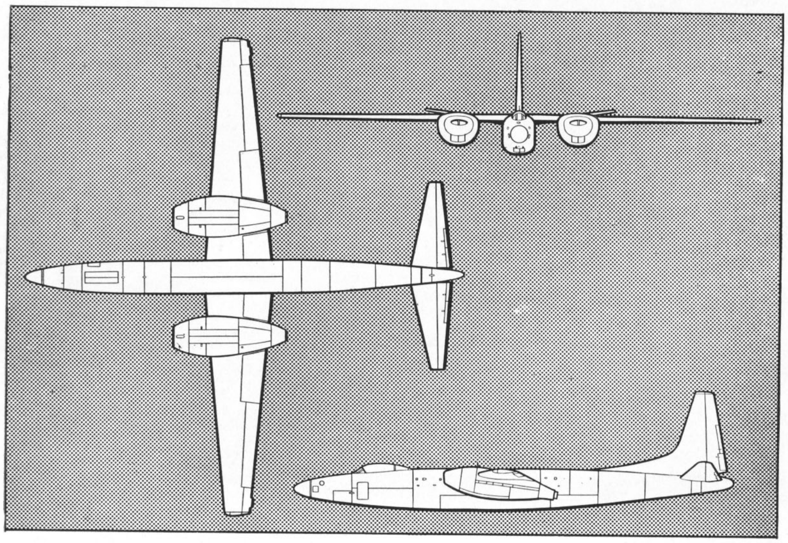








Characterised by an extremely graceful fuselage of high fineness ratio, only one example of the XB–46 was completed.

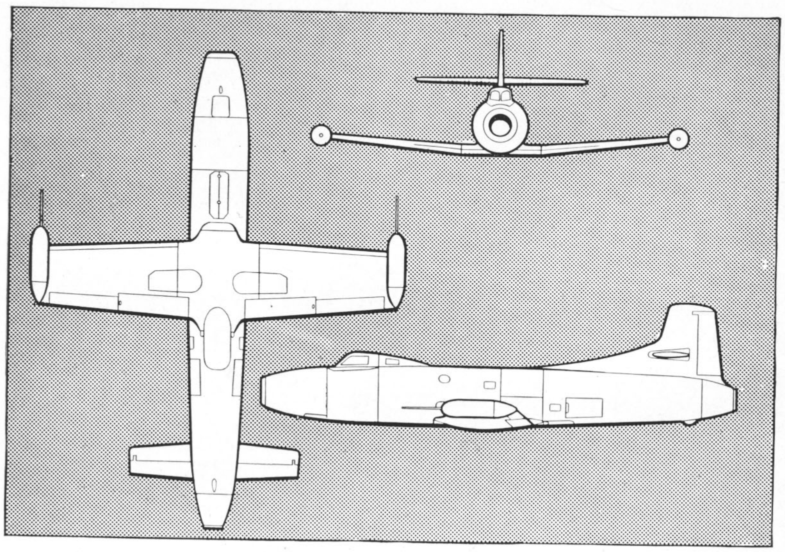


CONVAIR XB–46 (APRIL) 1947

The Convair Model 109, or XB–46, was an experimental medium bomber of exceptionally clean aerodynamic design, three prototypes of which were ordered by the U.S.A.F. in 1945. Only one XB–46 was completed, flying for the first time on April 2, 1947. and this was delivered to the U.S.A.F. for evaluation early in 1948. During the course of flight-testing the XB–46 flew from Oklahoma City to Wright Field at an average speed of 533 m.p.h.

The slim, oval-section fuselage was an all-metal, flush-riveted, stressed-skin structure with an overall length of 106 ft. The crew of three was accommodated in the pressurised section forward of the wing leading edge, pilot and co-pilot seated in tandem and the bombardier/navigator seated in the nose. The thin shoulder-mounted wing spanned 113 ft. and carried four 4,000 lb. thrust Allison-built General Electric J35–GE–3 turbojets mounted in pairs and housed in very large, underslung nacelles either side of the fuselage at quarter-span. The fuselage bomb-bay was designed to accommodate a maximum bomb load of 20,000 lb., and provision was made for remotely controlled, rearward-firing armament.

The thin, high-aspect-ratio wing combined with the exceptional fineness ratio of the fuselage resulted in extremely good performance at high altitude, and approximate maximum speed and service ceiling were 565 m.p.h. and 43,000 ft. respectively. Range with an 8,000-lb. bomb load was some 2,500 miles, and empty and loaded weights were 48,020 lb. and 91,000 lb. respectively. The success of the more radical Boeing XB–47 precluded the placing of orders for the B–46.



DOUGLAS SKYSTREAK (MAY) 1947

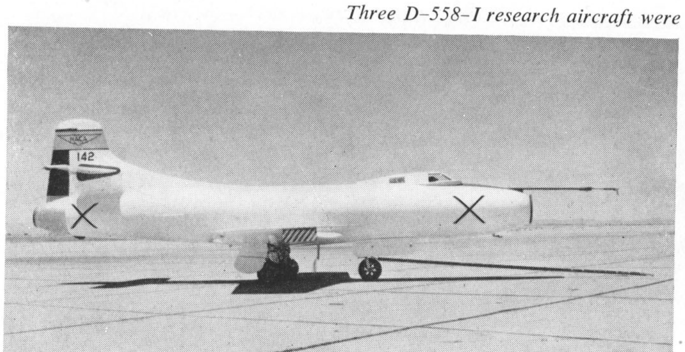
The D–558–I Skystreak, design work on which was initiated in 1945, was built to U.S. Navy requirements for an aircraft capable of high subsonic speeds to obtain in free flight air-load measurements not obtainable in wind tunnels existing at that time. The first of three Skystreak research aircraft was flown on May 28, 1947, and some three months later, on August 20, it established a world air speed record of 640·663 m.p.h., raising this figure five days later to 650·606 m.p.h.

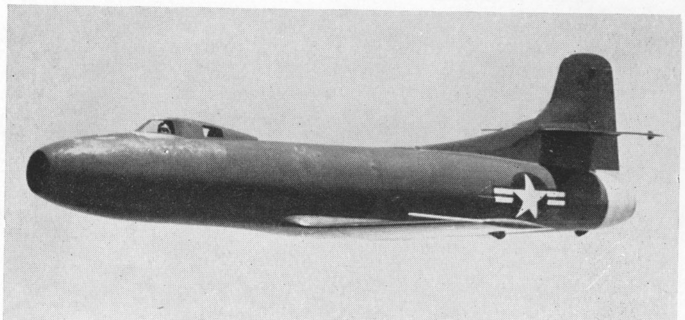
Carrying 640 lb. of research instruments and powered by an Allison J35–A–23 turbojet of 4,000 lb. thrust (later replaced by a J35–A–11 of 5,000 lb. thrust), the D–558–I Skystreak had a laminar-flow wing section with an aspect ratio of 4·15 and a 10 per cent thickness/chord ratio. The nose section of the fuselage could be jettisoned to enable the pilot to escape in an emergency. An automatic pressure-recording system was installed aft of the pilot and measurements were recorded from four hundred points on wings, fuselage and tail. Strain gauges were attached to links at three wing and three tail attachment points.

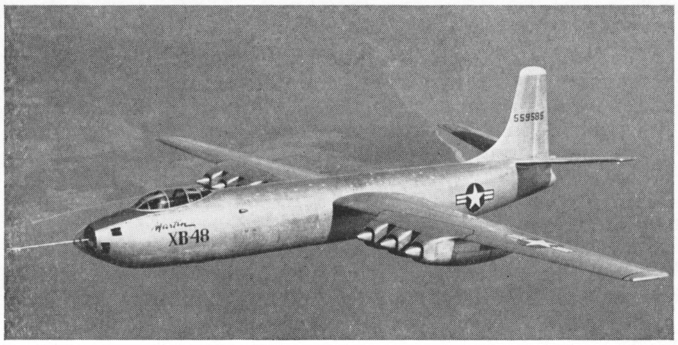
The Skystreak was essentially orthodox in basic design concept, and with a loaded weight of 9,750 lb., the wing loading of 65 lb./sq. ft. was low for a high-speed research aircraft. The three Skystreaks have been used for extensive flight research by the National Advisory Committee for Aeronautics.

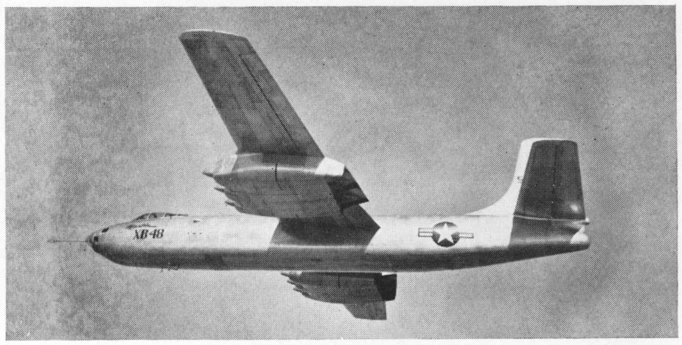
The Skystreak had a maximum speed of 651 m.p.h. The overall dimensions were as follows: span, 25 ft.; length, 35 ft. 1 in.; height, 12 ft. 2 in.; wing area, 150 sq. ft.

Three D–558–I research aircraft were built for subsonic flight investigation.









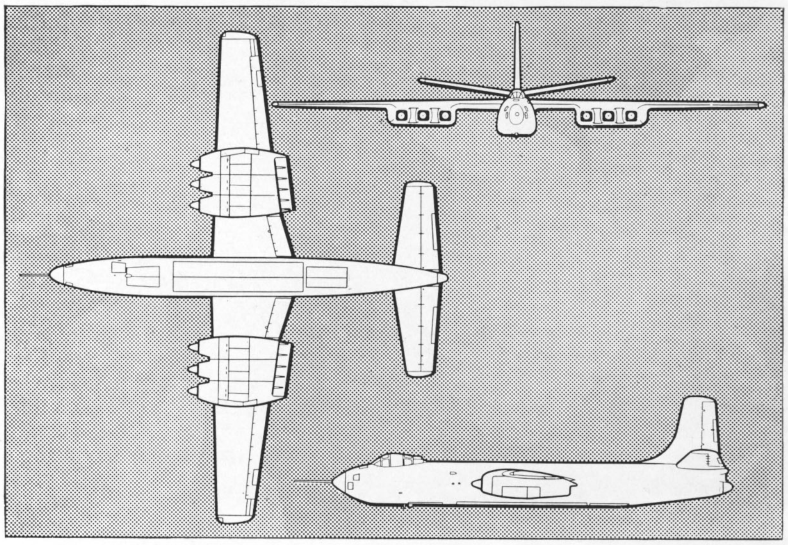
The XB–48's design is characteristic of those which marked the transitional period from piston-engines to jets in bomber design.

MARTIN XB–48 (JUNE) 1947

The Martin Model 223, or XB–48, is typical of the heavy jet aircraft designs which marked the period of transition from piston engines to turbojets. The XB–48 was almost entirely conventional in conception, being, in fact, based upon earlier piston-engined bomber projects, and its only unorthodox feature was the undercarriage which comprised dual mainwheel units retracting fore and aft of the bomb-bay and small out-rigged stabilising wheels.

The XB–48 was designed to meet the same requirements as those for which the Boeing XB–47 was conceived, and the first of two XB–48s flew on June 22, 1947, powered by six Allison-built General Electric J35–GE turbojets. These were grouped in threes and underslung on the shoulder-mounted laminar-flow section wing which had a span of 108 ft. 4 in. and an area of 1,300 sq. ft. The large, oval-section fuselage, which had a length of 85 ft. 9 in., accommodated a crew of three grouped in the nose section, and the fuselage bomb-bay was designed for a maximum capacity of 20,000 lb. for short-range missions. A remotely-controlled tail-gun position was projected.

The XB–48 weighed 58,500 lb. empty and 102,000 lb. loaded. Top speed was 495 m.p.h., and maximum range with 4,163 Imp. gal. of fuel and an 8,000-lb. bomb load, was 2,500 miles. Service ceiling was 43,000 ft. Take-off distance (over 50-ft. obstacle) was 5,200 ft., and landing speed (at 71,300 lb.) was 105 m.p.h. The performance of the XB–48 was not considered to be a sufficient advance over existing piston-engined medium bombers, and no production order was placed.

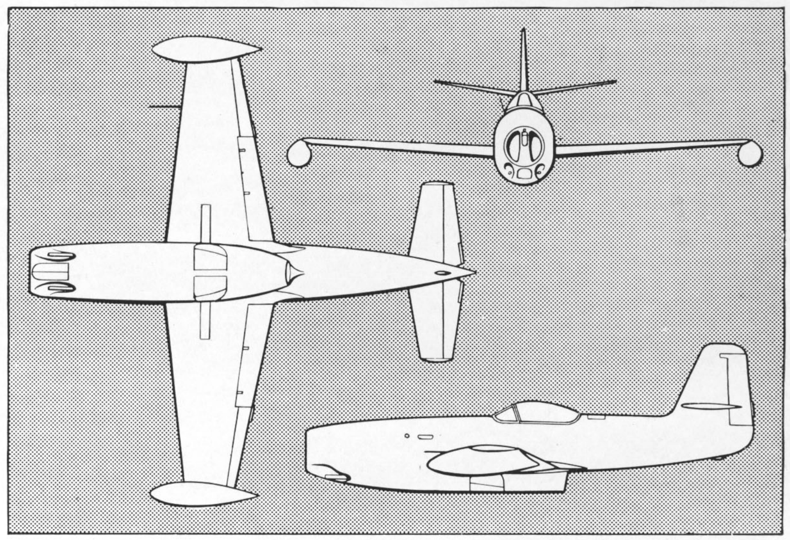


YAK–23 (FLORA) (MID) 1947

The YAK-23 single-seat fighter bears a strong family resemblance to Alexander Yakovlev's earlier YAK-15/17 series, employing the same basic layout. Surprisingly, the YAK-23 is a contemporary of the MIG-15 and presumably was placed in production as a safeguard against failure of the considerably more advanced and, at that time, unorthodox fighter.

The prototype YAK-23 apparently flew for the first time in the summer of 1947, employing one of the 3,500 lb. thrust centrifugal-type Rolls-Royce Derwent 5 turbojets newly acquired from Britain. Whereas the slim axial-flow turbojet of the YAK-15 series fighters had been installed in the lower part of the fuselage nose below the wing main spar, the girth of the centrifugal unit necessitated its installation ahead of the main spar in a deep, bulbous nose. However, the short jet pipe of the earlier aircraft was retained, which, together with the direct-entry air-intake orifice, suggests high engine efficiency. A simple, equi-tapered wing was employed and the main members of the nosewheel undercarriage retracted into fuselage housings, leaving the wing envelope free to accommodate fuel tanks.

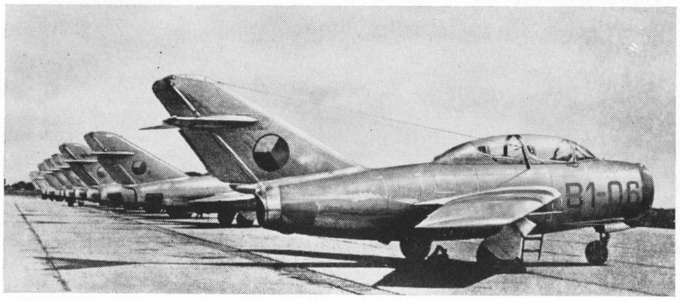
The YAK-23 appeared to be of simple, light-metal construction, and reports suggested that it was highly manœuvrable. Performance was comparatively high, maximum speed being in the vicinity of 610 m.p.h.; but the poorest design feature of the fighter was the positioning of the pilot's cockpit, forward and downward view being severely restricted. Currently serving with Russia's Balkan satellites, its approximate dimensions include a wing span of 30 ft. and a length of 29 ft.



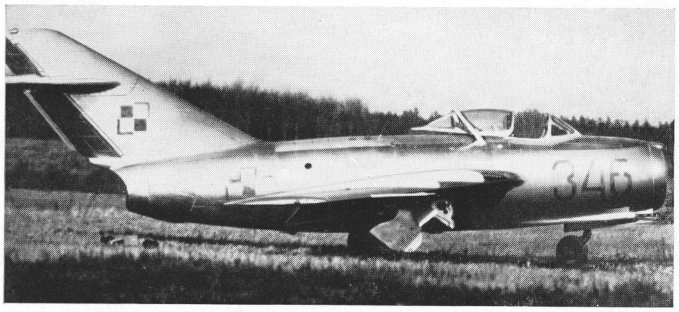
Contemporary with the MIG–15, the YAK–23 N.A.T.O. code name: Flora was a progressive development of Alexander Yakovlev's earlier jet-fighters.

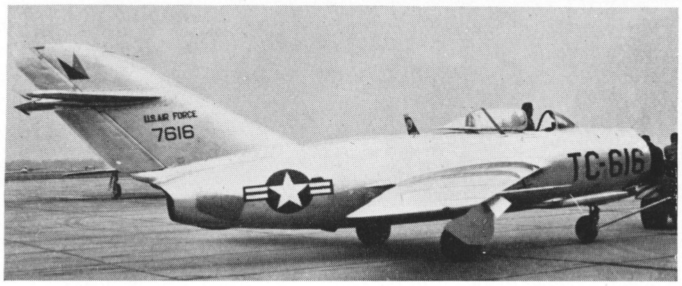
MIG-15 (FALCON)

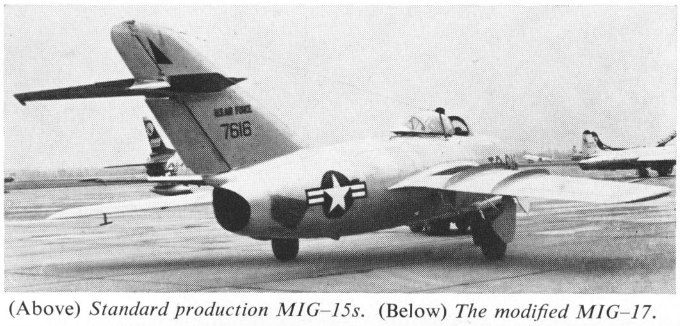
(JULY) 1947



(Above) *Two-seat U-MIG–15 trainers of the Czech Air Force.*







(Above) *Standard production MIG–15s.* (Below) *The modified MIG–17.*

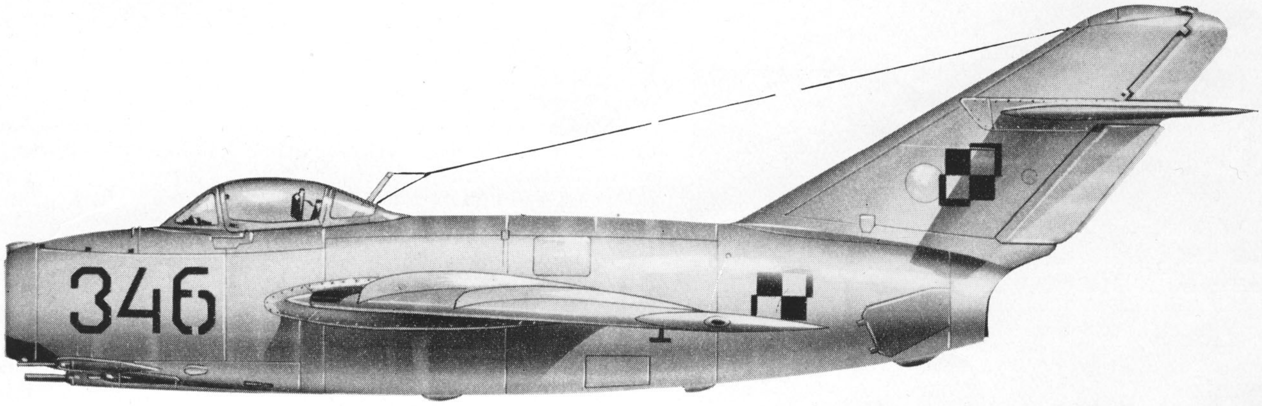
The MIG–15 single-seat interceptor fighter is particularly noteworthy as the first swept-wing jet combat aircraft to be placed in quantity production. Contemporary with the U.S. North American F–86 Sabre with which it makes interesting comparison, the MIG–15 owes much to German wartime research into wing sweepback, and its design displays strong Germanic influence. Reputedly designed by Artem I. Mikoyan and Mikhail A. Gurevich, the MIG–15 was originally intended for a 4,400 lb. thrust axial-flow turbojet (presumably derived from the German Junkers Jumo 004H), but with the delivery from Britain of several 4,850 lb. thrust Rolls-Royce Nene turbojets in the early part of 1947, the prototype MIG–15 was extensively modified to accommodate the centrifugal engine, being flown with this power plant on July 2, 1947.

Both fighter and turbojet were immediately placed in production, deliveries commencing in 1948. The production model differed from the first prototype in several respects, the most notable modifications being the lowering of the tailplane from the tip of the vertical tail surfaces and the cutting-back of the tail-pipe to reduce thrust losses. The initial production model was powered by a turbojet of 5,000 lb. thrust generally comparable to the Rolls-Royce Nene and reputedly designated VK–1, but in 1950 a progressive development of the turbojet, the VK–2, delivering 5,953 lb. thrust and 6,750 lb. thrust with water injection, was installed. Later production MIG–15 fighters also possessed increased armament, the 37-mm. N cannon installed semi-externally in the port-side nose lower decking and the 23-mm. NS cannon carried to starboard being augmented by an additional 23-mm. gun.

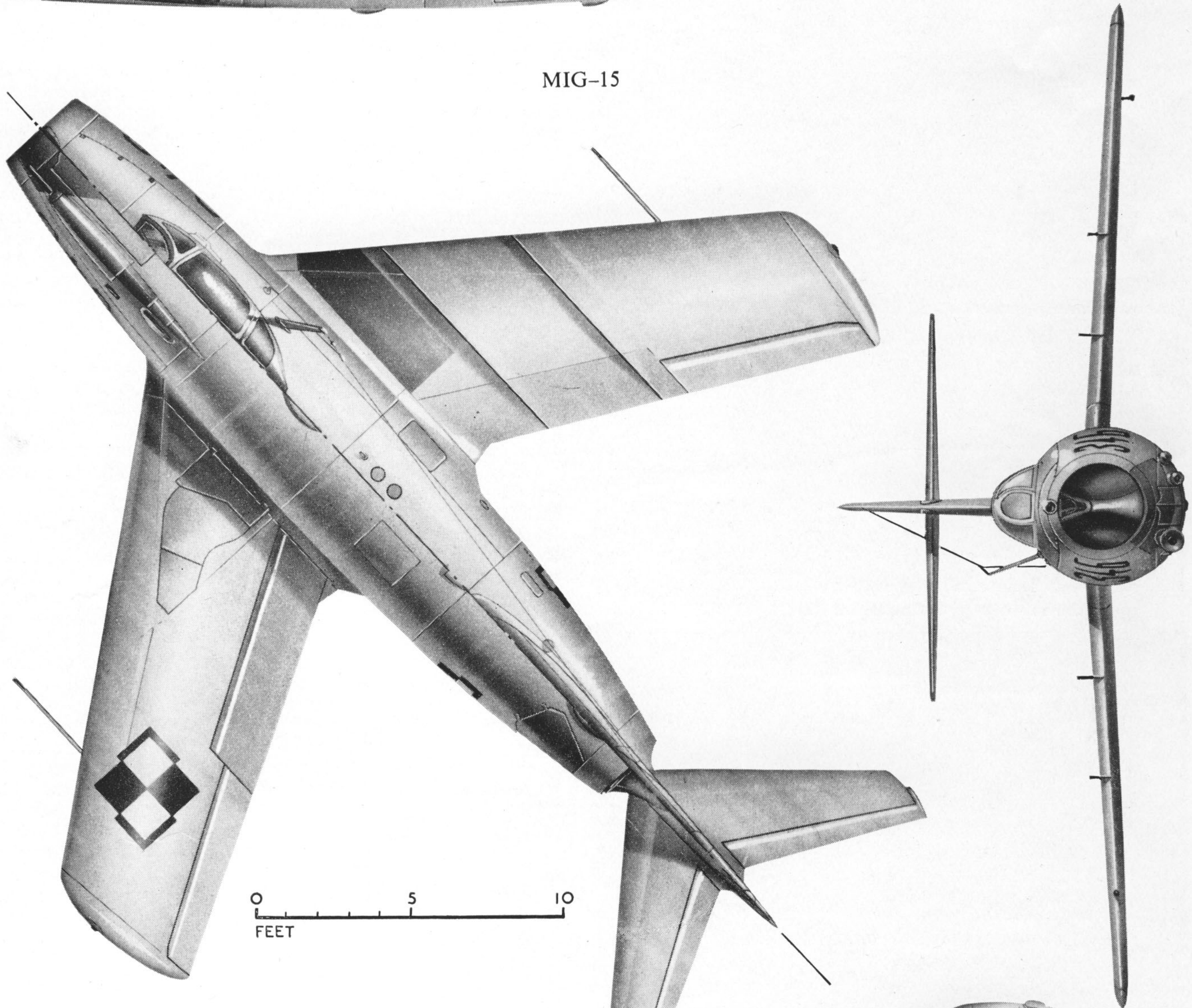
The MIG–15 has a comparatively short, circular-section fuselage of conventional semi-monocoque construction. A large, circular nose intake feeds air to the turbojet, the intakes bifurcating past the pilot's cockpit to the plenum chamber and the turbojet exhausting through a short tailpipe. The pilot's cockpit is pressurised and an ejector seat is installed. The cannon armament is installed as a pack which can be lowered from the fuselage on cables to facilitate servicing and rearming. The mid-positioned wing has an 8% thickness/chord ratio and is swept 42° on the leading edge, carrying slotted flaps of generous area inboard of the ailerons. It is believed that early MIG–15s carried slats on the leading edges of the wing outboard panels, but these were abandoned and supplanted by four large stall fences on the inboard panels. The undercarriage is of wide-track nosewheel type, the main members retracting inwards into wing housings.

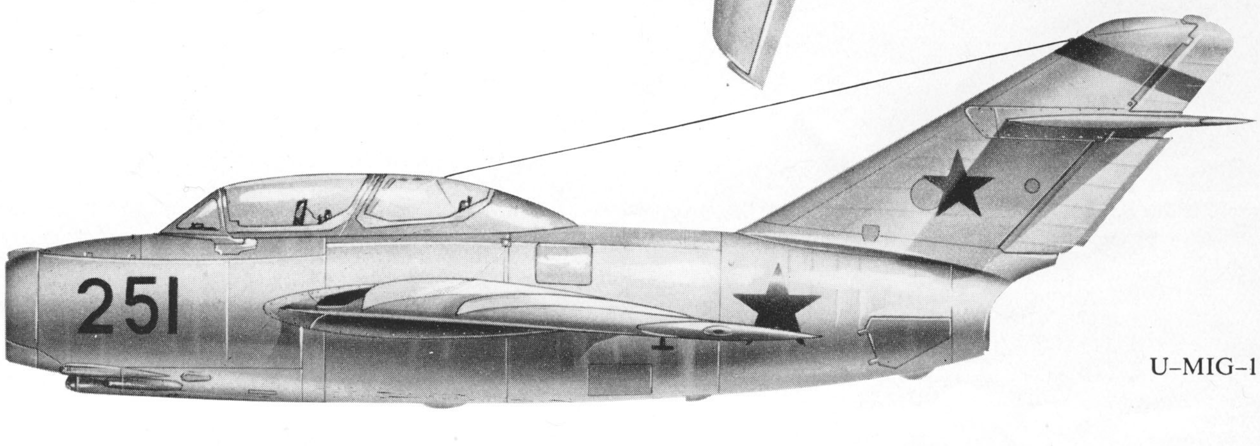
The internal fuel capacity of some 275 Imp. gal. provides an endurance of approximately 1 hr. 10 min. at 32,000 ft. Several conflicting sets of performance figures have been published for the VK–2-powered MIG–15, but the most reliable appear to be as follows: maximum speed, 683 m.p.h.; initial climb rate, 10,400 ft./min.; service ceiling, 51,000 ft.; stalling speed (clean), 130 m.p.h., (flaps and undercarriage extended), 118 m.p.h. Endurance can be extended to nearly 2 hr. by the addition of two close-fitting jettisonable 132 Imp.-gal. tanks on the wing inboard sections. Overall dimensions are: span, 33 ft. 1¼ in.; length, 36 ft. 4 in.; height, 11 ft. 2 in.; wing area, 185·677 sq. ft. Empty weight is 8,320 lb., and normal and maximum weights are 11,268 lb. and 14,238 lb. respectively.

Several variants of the basic MIG–15 are in service, including a tandem two-seat operational training version. Designated U-MIG–15, the training variant has a second seat for the instructor inserted aft of the normal seat, both being enclosed by a continuous canopy. The installation of the second seat necessitated some sacrifice of internal fuel tankage and the U-MIG–15 is normally flown with underwing tanks in position. Overall dimensions are identical with those of the single-seat fighter and performance is generally similar to that of the VK–1-powered MIG–15. An interim all-weather fighter derived from the MIG–15 is also reported to have been developed. With an additional fuselage section inserted to allow for increased internal tankage and extended wing outer panels with rounded tips; the all-weather fighter variant carries a radome above the air intake. A progressive development of the single-seat MIG–15, designated MIG–17, is now known to be in service with Soviet fighter elements. Featuring a 6° increase in leading-edge wing sweep with reduced thickness/chord ratio, and slightly modified tail surfaces, the MIG–17 is known by the N.A.T.O. code-name "Fresco". The code name "Falcon" has been given to the MIG–15.



MIG-15

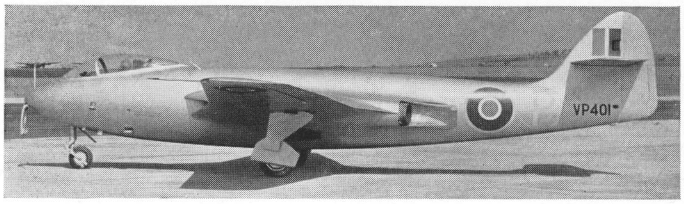




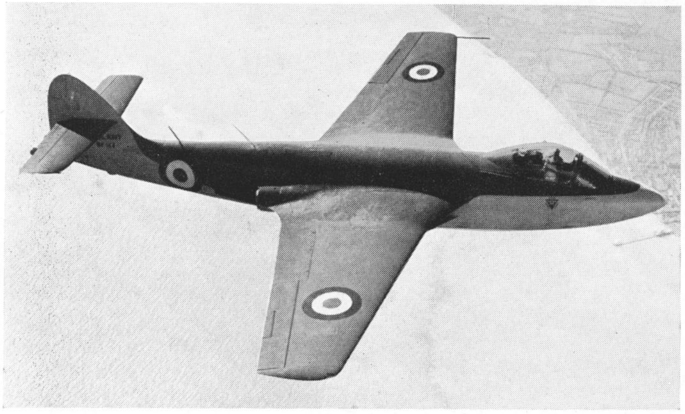
U-MIG-15

HAWKER SEA HAWK

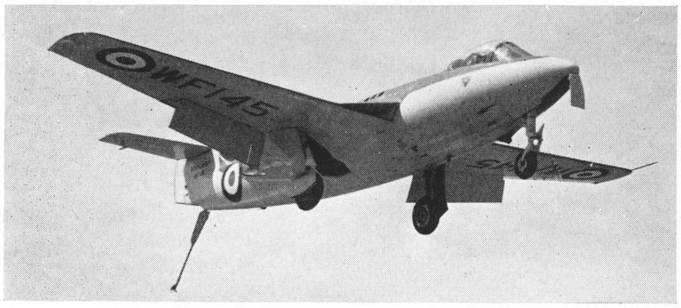
(SEPTEMBER) 1947



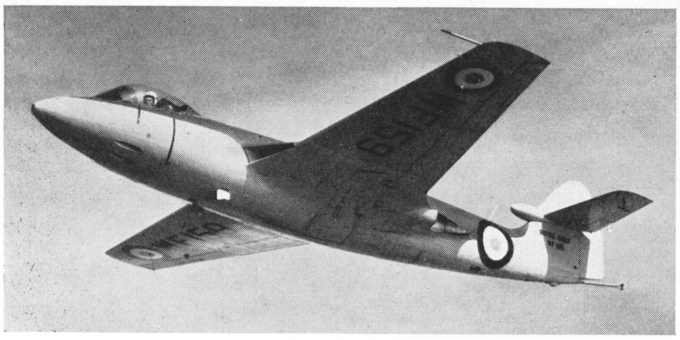
(Above) *The Hawker P.1040 (VP401) land-based forerunner of the Sea Hawk.*



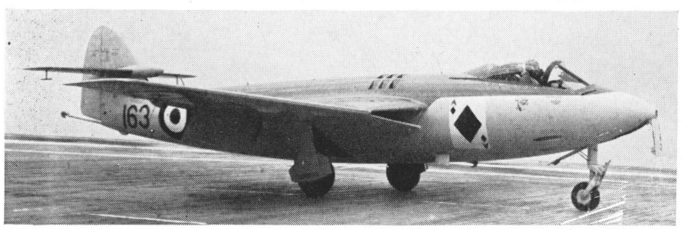
(Above) *An early production Sea Hawk F.1 (WF144) without tail "acorn".*



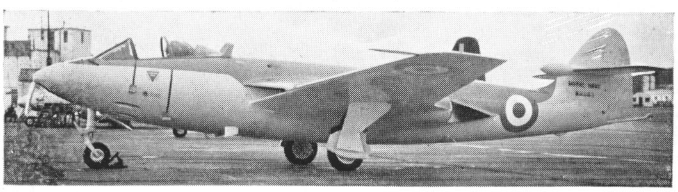
(Above) *An early production Sea Hawk (WF145).*



(Above) *A production Sea Hawk F.1 (WF159) with tail "acorn".*



(Above) *The Sea Hawk F.1.* (Below) *The Sea Hawk F.B.3.*



Design development of the Sea Hawk single-seat carrier-borne fighter-bomber dates back to the end of 1944, when the initial project design for a single-seat, land-based interceptor fighter, the P.1040, was finally crystallised. The P.1040 was not accepted for the R.A.F., but in December 1945 the Navy invited tenders for a carrier-borne interceptor, and the basic design was adapted to meet specification N.7/46, three prototypes being ordered in February 1946.

The P.1040 was eminently suited for naval use as the novel "bifurcated trunk" arrangement of its exhaust system coupled with wing-root intakes left the fuselage free of ducting to house large-capacity fuel tanks fore-and-aft of the turbojet, providing a radius of action comparable to that of its piston-engined equivalents. The first prototype with fixed wings and no naval equipment flew on September 2, 1947, and the first of two fully navalised prototypes was flown in the autumn of 1948. Production commenced with the Sea Hawk F.1, powered by a 5,000 lb. thrust Rolls-Royce Nene 101 (R.N.2) turbojet, initial production machines being produced by the parent company, production subsequently being entrusted to Sir W. G. Armstrong Whitworth Aircraft Ltd.

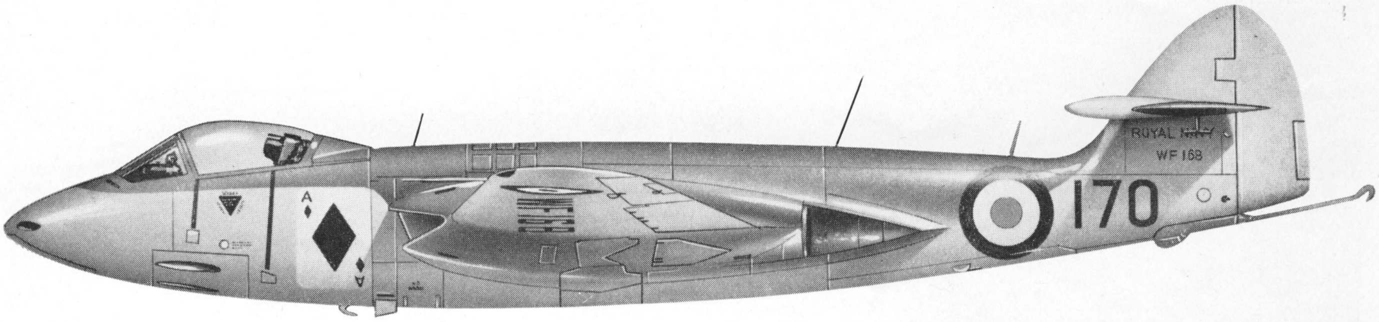
The Sea Hawk F.1 differed from the prototypes in several respects. Wing span was increased from 36 ft. 6 in. to 39 ft., which increased gross wing area from 268 to 278 sq. ft., the area of the horizontal tail surfaces was increased and the cockpit canopy was redesigned. The Sea Hawk F.1 was succeeded in production by the F.2, with power-boosted ailerons, and the F.B.3, which features a strengthened wing for external underwing loads of bombs or rocket missiles. Both F.2 and F.B.3 are externally similar to the earlier Sea Hawk F.1.

The Sea Hawk is a very beautiful mid-wing monoplane with an overall length of 39 ft. 8 in. and a height of 8 ft. 8 in. The nose and centre portions of the all-metal fuselage are of semi-monocoque construction reinforced by a box-section keel member and four longerons, and the rear portion is a pure monocoque of which the fin base is an integral part. The fuselage is stressed for tail-down accelerated take-offs, a single take-off point being positioned beneath the fuselage. The armament comprises four 20-mm. British Hispano cannon in the lower decking of the forward fuselage, and the pilot is seated close to the nose in a pressurised cockpit with a Martin-Baker ejector seat. The forward positioning of the cockpit and the generous proportions of the canopy provide exceptional pilot-view for deck operations.

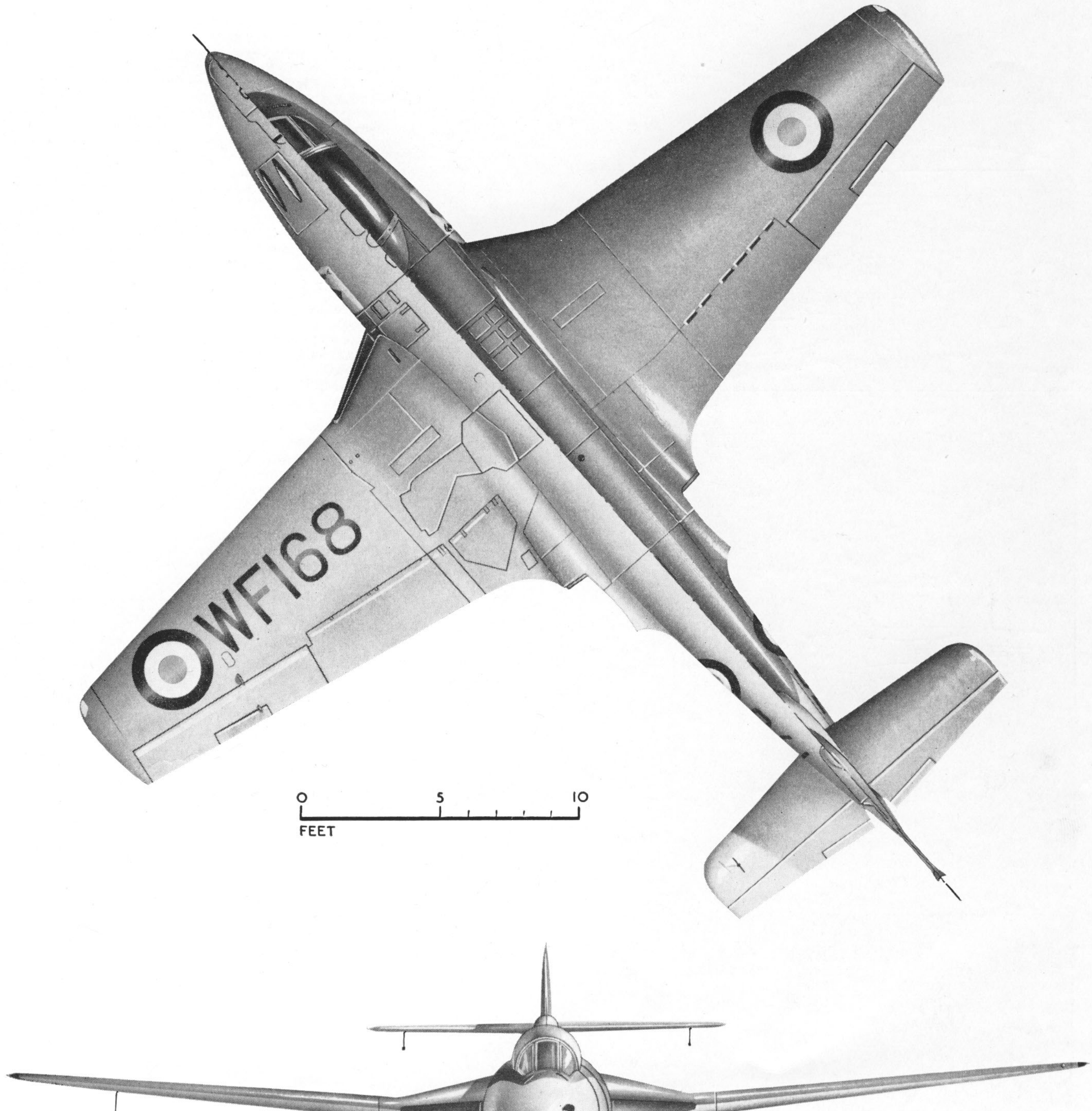
The Nene engine is fed via large intakes in the thick wing roots which discharge at low velocity into the plenum chamber. Aft of the turbojet the exhaust pipe is bifurcated, the twin tail pipes emerging from the fuselage aft of the trailing-edge wing roots, the thickness of which is maintained throughout the chord. Air supply to the engine is augmented through spring-loaded traps in the fuselage walls. The engine ducting arrangement greatly reduces the frictional losses associated with the more usual long intake and exhaust system and leaves the fuselage free to house exceptionally large fuel tanks which provide the Sea Hawk with a radius of action of the order of 700 miles. This can be increased by 45 Imp. gal. or 90 Imp. gal. drop-tanks carried under the inboard wing sections. The undercarriage is of nosewheel type, the main members retracting inwards into wheel wells in the fuselage, and the nosewheel retracting forward.

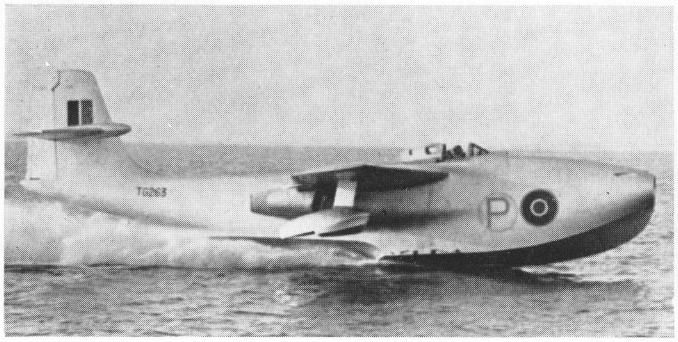
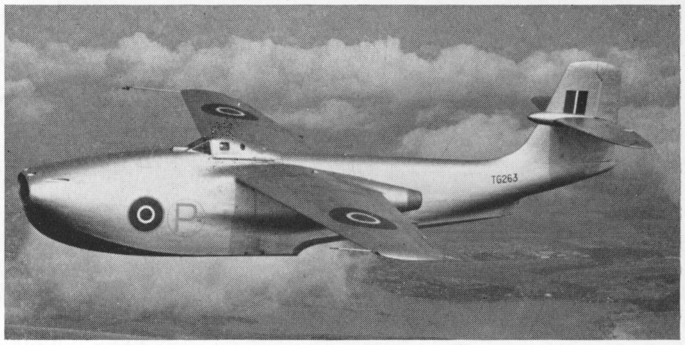
The mid-positioned wing has stressed heavy-gauge skin, and the outer wings are attached to stub-wings by two hinge fittings with automatic locks and a spigot bearing in the leading-edge. The wing outer sections power-fold upwards to provide a folded width of 13 ft. 4 in. Combined hydraulically operated landing and brake flaps of double-split type are carried inboard of the powered ailerons, and a variety of underwing ordnance loads can be carried. The Sea Hawk's maximum speed is in the vicinity of 630 m.p.h. at sea level, and initial climb rate is 8,000–9,000 ft./min. A Sea Hawk F.B.3 flew from London to Amsterdam in 23 min. 39·7 sec., representing an average speed of 571 m.p.h., in the summer of 1954.

The original land-based prototype of the Sea Hawk, the P.1040, was adapted in 1950 as a flight test-bed for the Armstrong Siddeley Snarler A.S.Sn. 1 rocket engine. With the Snarler installed in the rear fuselage, the prototype was redesignated P.1072, and the first flight test was made on November 20, 1950. With 2,000 lb. thrust available from the Snarler, the climb rate of the P.1072 was increased 500% at 30,000 ft.

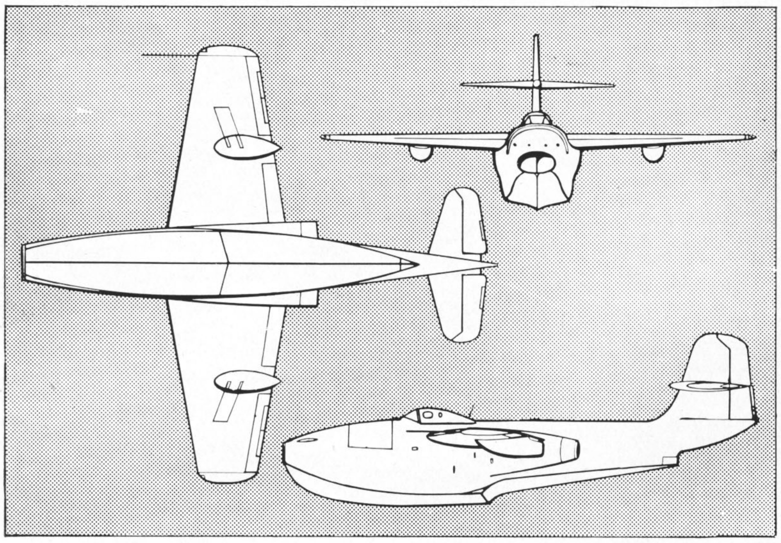


HAWKER SEA HAWK F. 1



The world's first jet flying-boat, three S.R.A.1 prototypes were built. The third prototype ,TG263 ,is illustrated here.

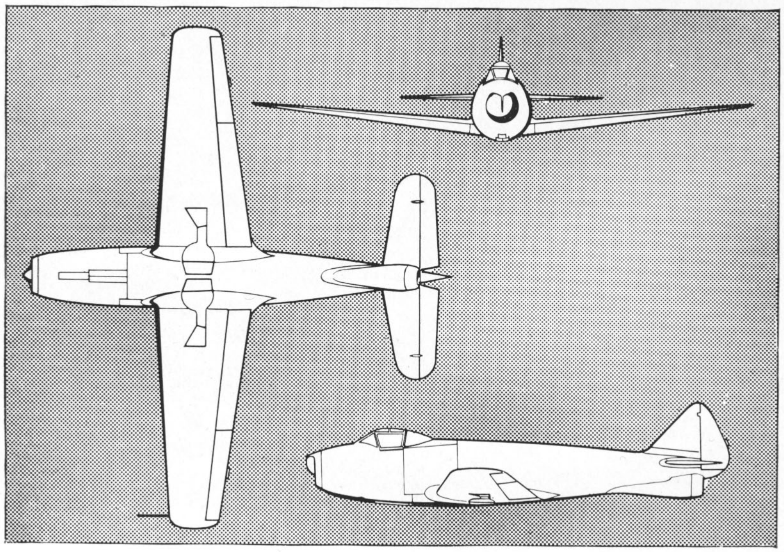


SAUNDERS-ROE S.R.A.1 (JULY) 1947

The unique operational flexibility of the water-based fighter has attracted many aircraft designers but, owing to hull drag, the flying-boat fighter employing a conventional hull structure cannot compete in level speed with its land-based counterpart. However, the water-based fighter can perform a variety of useful roles, and the obvious value of such combat aircraft during the war in the Pacific resulted in the issue of specification E6/44, which called for a single-seat, twin-jet fighter flying-boat.

To meet the requirements of this specification, Saunders-Roe Ltd. produced the S.R.A.1, which, while of conventional construction and employing conventional hull design, embodied several features which were, at the time of its appearance, novel. The first of three S.R.A.1 prototypes flew on July 16, 1947, powered by two 3,250 lb. thrust Metropolitan Vickers Beryl M.V.B.1 turbojets housed in the hull with a common intake in the nose and outlets just aft of the wing. The first prototype, which was the world's first jet flying-boat, was followed by a second machine powered by two 3,500 lb. thrust Beryl M.V.B.2 turbojets, and a third prototype powered by two 3,850 lb. thrust Beryl 1 (M.V.B.2) units.

The S.R.A.1 had a normal fuel capacity of 425 Imp. gal., and jettisonable fuel tanks could be carried under the wing inboard of the retractable stabilising floats. Loaded weight was 16,255 lb., and empty weight was 11,262 lb. The third prototype attained a maximum speed of 516 m.p.h., and initial climb rate exceeded 4,000 ft./min. Dimensions were: span, 46 ft.; length 50 ft.; height, 16 ft. 9 in.; gross wing area, 415 sq. ft.



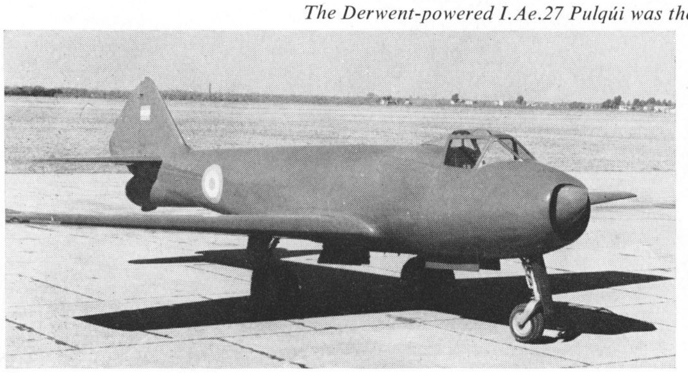
I.Ae.27 PULQÚI (AUGUST) 1947

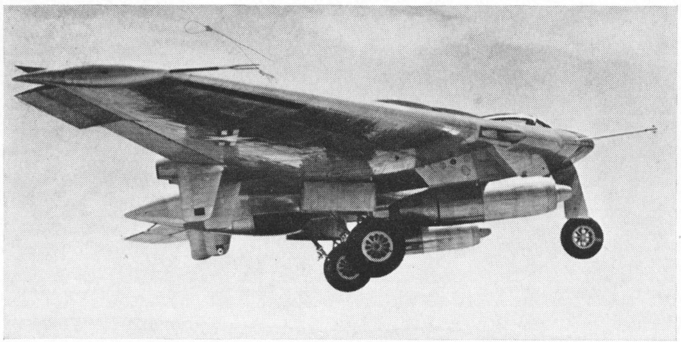
The I.Ae.27 Pulqúi (Arrow) single-seat experimental fighter was the first jet-propelled aircraft to be designed and built in Latin America. Flown for the first time on August 9, 1947, the Pulqúi was designed by the exiled French designer Emile Dewoitine, who was assisted by Commodore Juan San Martin of the Institute Aerotecnico (since renamed Industrias Aeronauticas y Meccanicas del Estado) at Cordoba, Argentina.

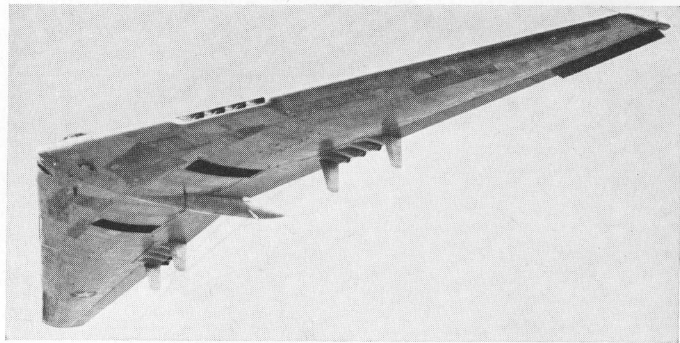
The Pulqúi was a simple low-wing cantilever monoplane of all-metal construction. The wing was of laminar-flow section and had a span and gross area of 36 ft. 11 in. and 212 sq. ft. respectively. The fuselage was of circular section, with a nose air intake which divided and passed either side of the pilot's cockpit to feed air to the 3,500 lb. thrust Rolls-Royce Derwent R.D.5 turbojet, which exhausted below the tail assembly. The limited internal capacity of the fuselage necessitated the positioning of all fuel tanks in the wing and their capacity (264 Imp. gal) were insufficient to provide the Pulqúi with a satisfactory endurance, and it was proposed to attach jettisonable auxiliary tanks outboard of the wheel wells. Fuselage length and height to fin tip were 31 ft. 9½ in. and 11 ft. 1 in.

The Pulqúi possessed a maximum speed of 528 m.p.h. and an initial climb rate of 4,920 ft./min. Ceiling was 50,840 ft. and projected fixed armament comprised four 20-mm. guns in the fuselage nose. For short-range attack missions it was proposed to attach rocket rails or racks for light bombs under the wing and, as an interceptor, the loaded weight of the Pulqúi was 7,920 lb.

The Derwent-powered I.Ae.27 Pulqúi was the first jet aircraft to be designed in Latin America.





(Above, left) *The YRB–49A experimental photo-reconnaissance aircraft.* (Above, right, and g.a. drawing) *The YB–49 experimental bomber.*

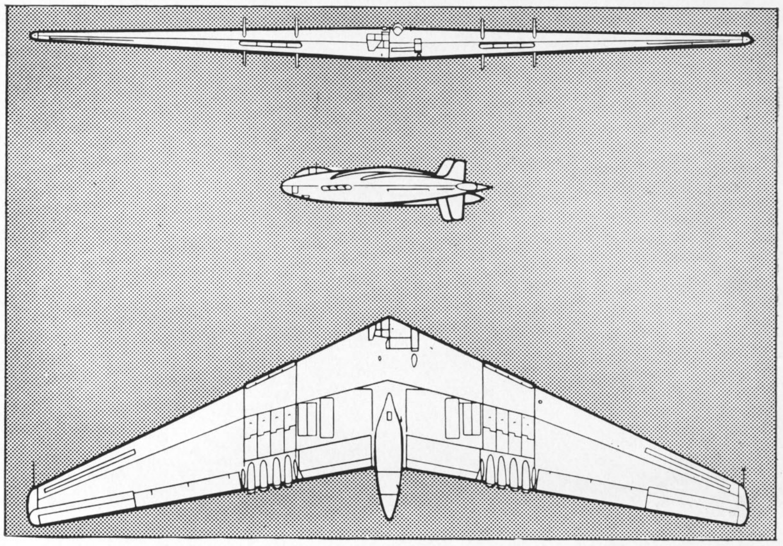
NORTHROP YB–49 (OCTOBER) 1947

The most spectacular of the series of "flying-wing" aircraft developed by John K. Northrop, and perhaps the most advanced aerodynamic and structural designs of their day, were the YB–49 and YRB–49A. The all-wing layout is undoubtedly superior to more conventional large airframes in respect of drag reduction, increased range, speed and weight-lifting ability for the same power as, since weight is distributed along the span, a comparatively light structure is possible. This results in a very favourable ratio of gross weight to empty weight.

Basically similar in so far as they were both conversions of the piston-engined XB–35 bomber, the YB–49 and the YRB–49A differed primarily in that the former had eight 4,000 lb. thrust Allison J35–A–5 turbojets buried in the wing and the latter had six 5,600 lb. thrust Allison J35–A–21 turbojets, two of which were suspended beneath the wing.

Two YB–49 prototypes were produced, the first flying on October 21, 1947. The YB–49 possessed empty and loaded weights of 88,100 lb. and 213,000 lb. respectively. Maximum speed was 520 m.p.h. at 30,000 ft., and a YB–49 flew non-stop for 3,458 miles at a speed of 382 m.p.h.

The YRB–49A was intended for photo-reconnaissance duties and made its first flight on May 4, 1950. Empty and loaded weights were 88,500 lb. and 206,000 lb. respectively. Only one YRB–49A was built and flown before the all-wing bomber programme was abandoned by the U.S.A.F. Overall dimensions were: span, 172 ft.; length, 53 ft. 1 in.; height, 15 ft.



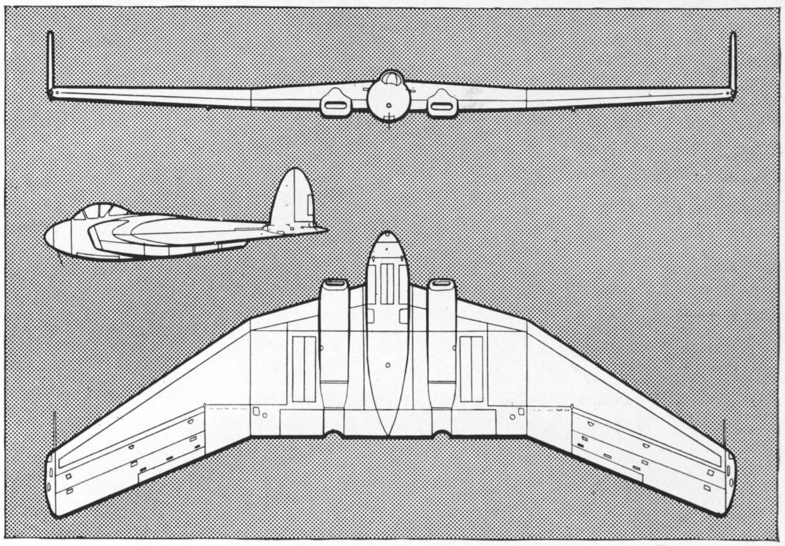
ARMSTRONG WHITWORTH A.W.52 (NOVEMBER) 1947

The Armstrong Whitworth A.W.52 was an aircraft of extreme beauty, designed expressly as a research machine for determining the flying characteristics of large tailless aircraft and to provide data for a projected six-jet high-speed transport of generally similar configuration. The first prototype A.W.52 flew on November 13, 1947, powered by two 5,000 lb. thrust Rolls-Royce Nene turbojets. A second prototype, powered by two 3,500 lb. thrust Rolls-Royce Derwent units followed on September 1, 1948, but the latter machine was destroyed early in its flight-test programme.

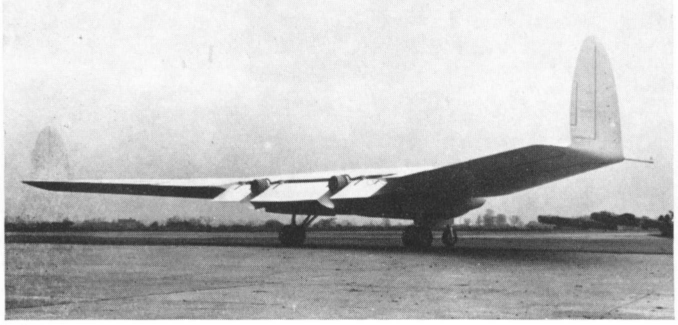
Carrying a crew of two, the A.W.52 had a span of 90 ft. and a gross wing area of 1,314 sq. ft. The outboard wing sections were swept at an angle of 35° at the leading edge, and longitudinal and lateral control was achieved by means of elevons hinged on each outer wing section. Directional control of yaw was attained with wingtip fins and rudders. Length and height were 37 ft. 4 in. and 14 ft. 5 in. respectively.

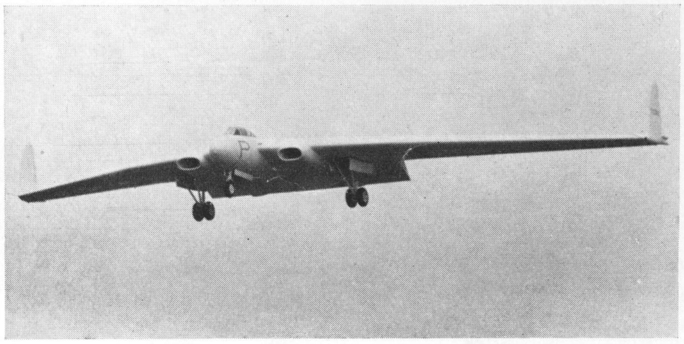
In the following comparison of performance and weights for the two A.W.52 research aircraft, those for the Derwent-powered aircraft are quoted in parentheses: maximum speed, 500 (450) m.p.h.; service ceiling, 50,000 (45,000) ft.; normal range at 36,000 ft., 1,500 miles.; maximum range, 2,130 miles; initial climb rate, 4,800 (2,500) ft./min. Empty and loaded weights were 19,662 (19,185) lb. and 34,154 (33,305) lb. respectively.

The Nene-powered first prototype A.W.52 completed a prolonged research programme and is undoubtedly one of the most graceful aircraft ever flown.



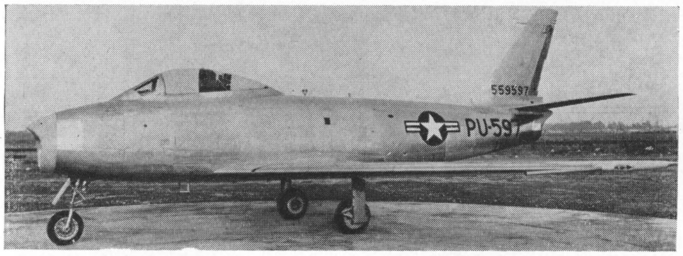
(Below, left) *The Derwent-powered A.W.52 research aircraft.* (Below, right, and drawing) *The Nene-powered A.W.52.*



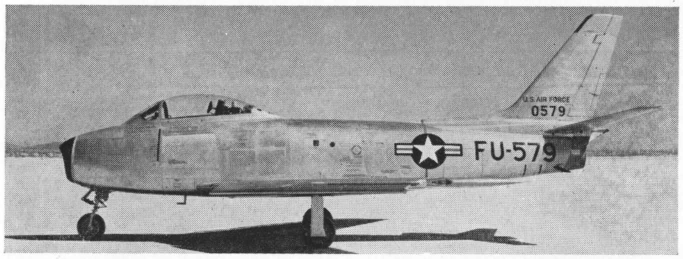


NORTH AMERICAN F-86 SABRE

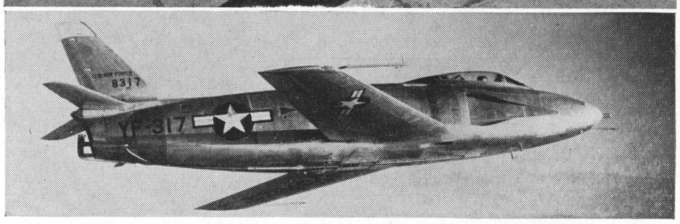
(OCTOBER) 1947



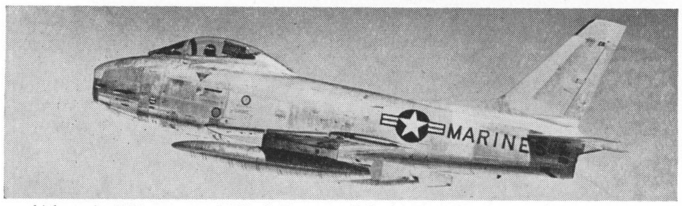
(Above) *First prototype Sabre, the XF–86 (45–59597).*



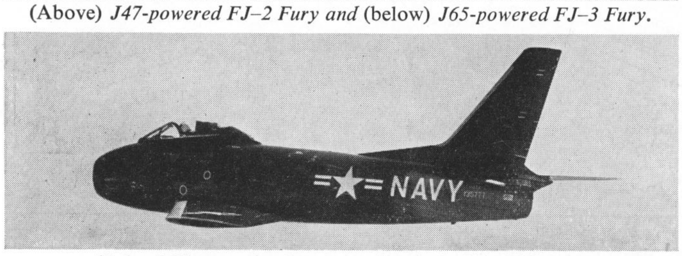
(Above) *F–86E–1–NA and* (below) *F–86F with extended wing.*



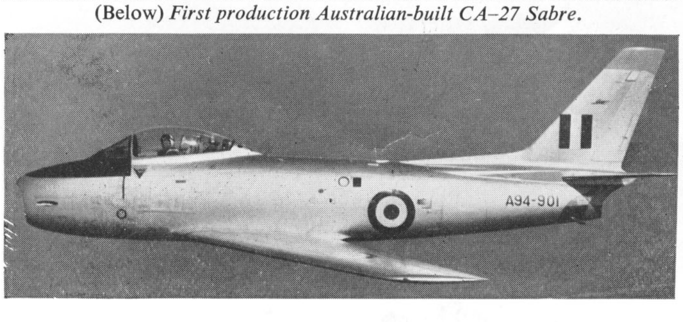
(Above) *F–86C (YF–93A) powered by a J48–P–6 turbojet.*



(Above) *J47-powered FJ–2 Fury and* (below) *J65-powered FJ–3 Fury.*



(Below) *First production Australian-built CA–27 Sabre.*



Like its Russian contemporary, the MIG–15, the F–86 Sabre single-seat fighter owes much to German wartime swept-wing research. Originally conceived as a land-based version of the FJ–1 Fury carrier-borne fighter with unswept wing, the original design was modified in the light of German research data by the adoption of a 35° swept wing with which it was found that maximum speed could be increased by some 70 m.p.h. The first prototype, the XP–86, flew on October 1, 1947, powered by the 3,750 lb. thrust General Electric (Chevrolet-built) J35–C–3, and an order for 221 production F–86A fighters was placed by the U.S.A.F. on December 28, 1947.

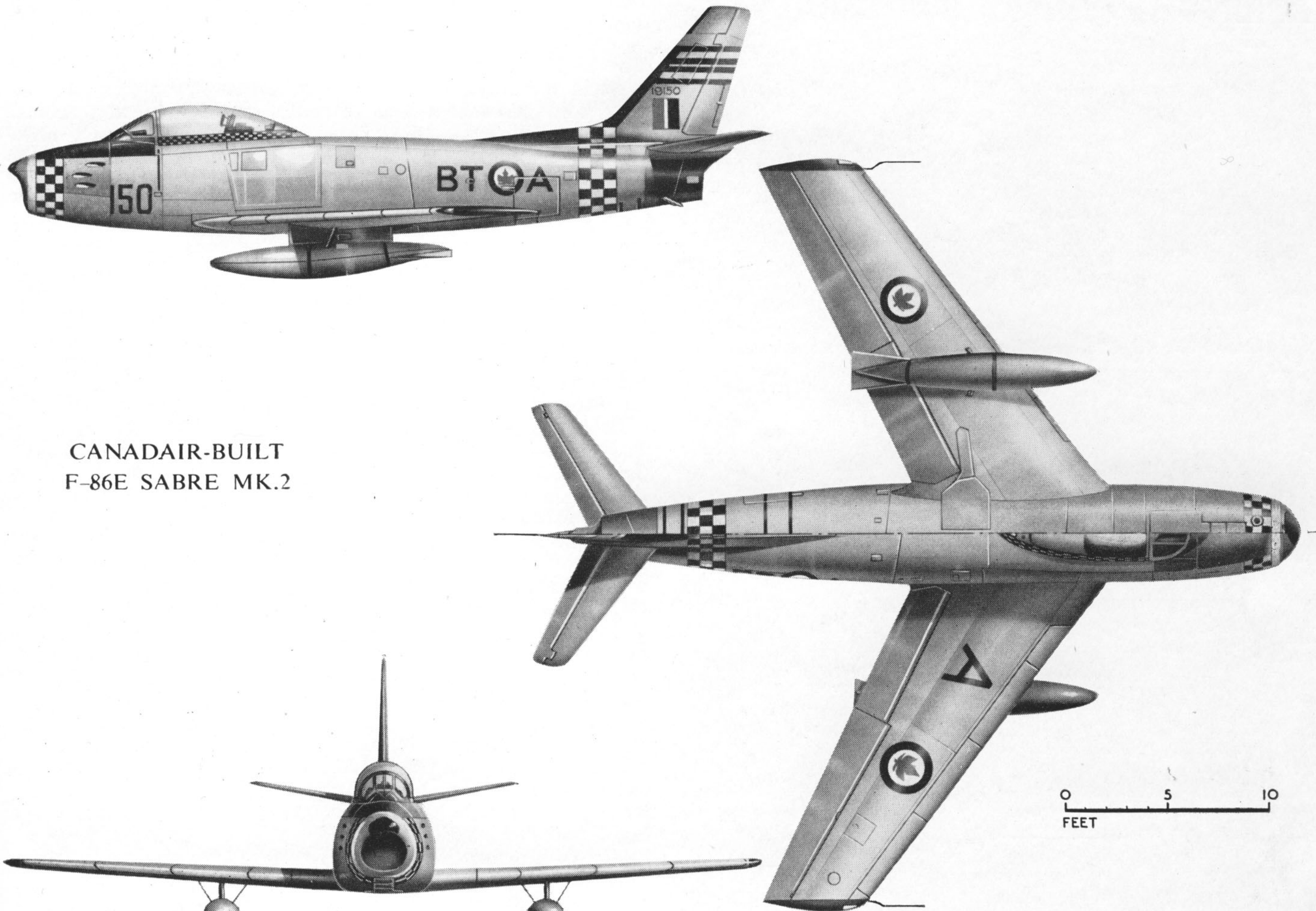
In the meantime the General Electric J47–GE–1 of 4,850 lb. thrust had reached an advanced stage, and this was installed in the first production F–86A fighter which flew on May 18, 1948. Successive production batches of F–86A Sabres were powered by the 5,200 lb. thrust J47–GE–3, –9 and –13 engines, and a total of 554 F–86A Sabres had been built when production ceased in favour of the improved F–86E in December 1950. With the J47–GE–13 turbojet developing 5,200 lb. thrust dry and 6,000 lb. thrust with water injection, the F–86A had a maximum speed of 633 m.p.h. (dry) and 673 m.p.h. (wet) at sea level, and an initial climb rate of 5,400 ft./min. (dry) and 6,860 ft./min. (wet). Empty weight was 9,200 lb., normal loaded, 13,715 lb., and maximum loaded, 16,500 lb.

The F–86B was a projected version with an enlarged fuselage which was cancelled in favour of the all-weather F–86C. The latter had a radically redesigned fuselage, with NACA flush air intakes feeding a Pratt and Whitney J48–P–6 which, with afterburning, provided 8,750 lb. thrust. The F–86C was first flown on January 25, 1950, and was redesignated YF–93A, but production contracts for this model were cancelled. The F–86D is a further all-weather fighter model first flown on December 22, 1949. The F–86D carries A.I., gun-laying, and tracking, navigation and transponder radar and is powered by a J47–GE–17 engine rated at 5,400 lb. thrust and 7,350 lb. thrust with afterburning. Armament comprises twenty-four 2·75-in. Mighty Mouse rockets in a retractable under-fuselage tray. Maximum speed is 660 m.p.h. (715 m.p.h. with afterburning), and approximate loaded weight is 18,250 lb.

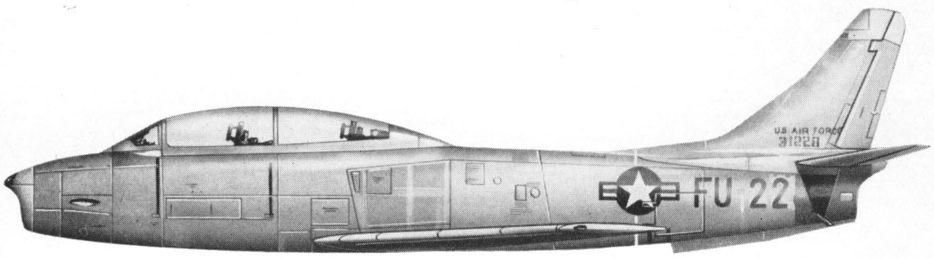
The F–86E was a progressive development of the F–86A, and the first was delivered in March 1951. It differed from the A subtype in having a new control system incorporating an "all-flying" tail, both tailplane and elevator moving as one with increases in incidence. Production of the F–86E was completed in April 1952 and replaced by the F–86F with a 6,100 lb. thrust J47–GE–27 engine. Wing slats were later replaced by a new leading edge extended 6 in. at the root and 3 in. at the tip. This improved high-altitude manœuvrability but increased stalling speed and yaw-and-roll effect at low speeds. The F–86F has a top speed of 680 m.p.h. at sea level and 630 m.p.h. at 35,000 ft. Dimensions are: span 37 ft. 1 in., length, 37 ft. 6 in., height, 14 ft. 7 in., wing area, 287·9 sq. ft. The F–86G project was abandoned in favour of the slightly larger F–86H fighter-bomber powered by the 9,300 lb. thrust General Electric J73–GE–3 and intended primarily for low-level attack. The F–86K is a development of the F–86D with an 8-in. increase in fuselage length (41 ft. 8 in. to 42 ft. 4 in.), an armament of four 20-mm. M–39 cannon and a 5,600 lb. thrust J47–GE–33 engine.

Several deck-landing versions of the Sabre have been produced, including the FJ–2 Fury, an adaptation of the F–86E, with a 6,100 lb. thrust J47–GE–27, folding wing and arrester gear, the FJ–3 with a 7,200 lb. thrust Wright J65–W–2, and the FJ–4 with a 7,800 lb. thrust J65–W–4. All Furies have a four 20-mm. cannon armament, and the FJ–4 has a completely new wing of greater chord and consequently lower thickness/chord ratio, and thinner tail surfaces. The TF–86F is a two-seat conversion trainer variant of the F–86F fighter.

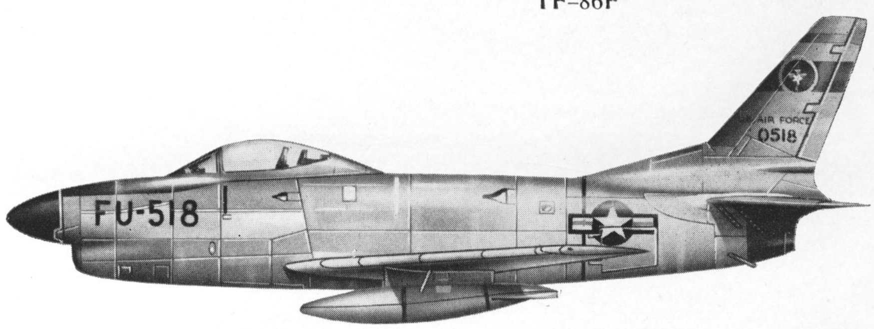
Versions of the Sabre are built under licence in Canada and Australia. The Canadair Sabre Mk.1 was an F–86A which served as a prototype for J47–powered Marks 2 and 4 Sabres. The Sabre Mark 3 was a converted North American-built F–86E with an Avro Orenda turbojet, and the Sabre Marks 5 and 6 are powered by the 6,500 lb. thrust Orenda 10 and 7,275 lb. thrust Orenda 14 respectively. The Australian Sabre, built by Commonwealth Aircraft, is designated CA–27 and is powered by the 7,500 lb. thrust Australian-built Rolls-Royce Avon Mk.20 (R.A.7). It carries an armament of two 30-mm. Aden guns.



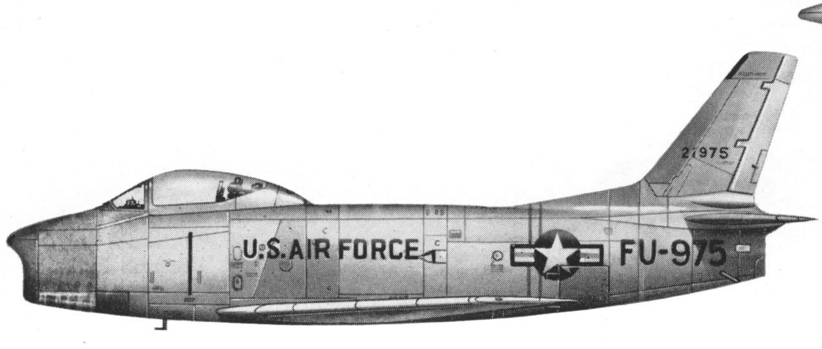
CANADAIR-BUILT
F-86E SABRE MK.2



NORTH AMERICAN
TF-86F

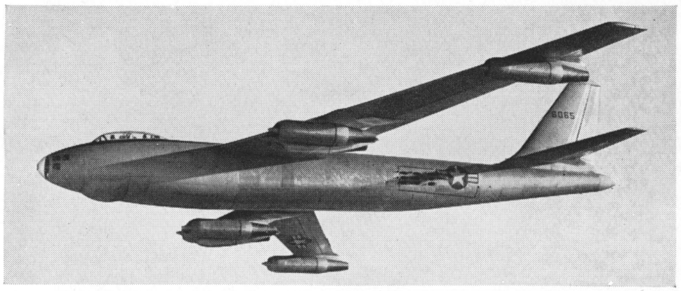


NORTH AMERICAN F-86D
SABRE

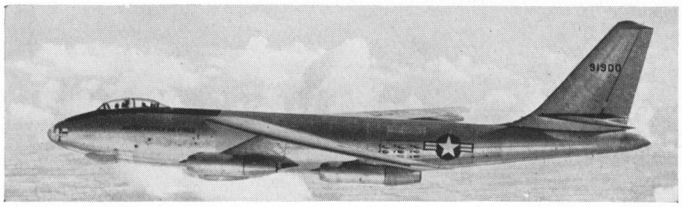


NORTH AMERICAN F-86H
SABRE

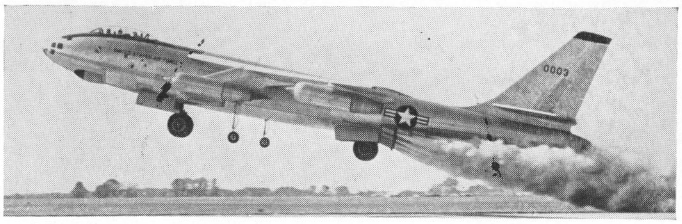
BOEING (Model 450) B-47 STRATOJET (DECEMBER) 1947



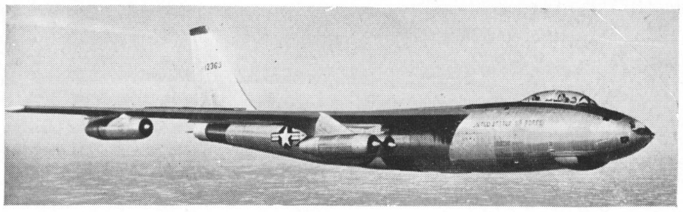
(Above) *The XB–47 Stratojet (46–065) with Allison J35 engines.*



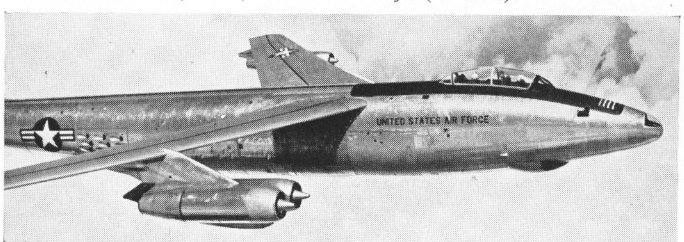
(Above) *A pre-production B–47A Stratojet (49–1900).*



(Above) *A B–47B Stratojet (50–003) taking off with 33 JATO bottles.*



(Above) *A B–47E Stratojet (51–2363).*



(Above) *The RB–47E (51–5259) specialised photo-reconnaissance variant, and* (below) *a B–47E being refuelled by a KC–97G tanker.*

The B–47 Stratojet was the first swept-wing bomber to be built in quantity. Its design, initiated in September 1945, is very bold in concept and embodies several radical features. Characterised by a thin, flexible wing of high aspect ratio swept at an angle of 35° and carrying six turbojets mounted in underwing pods, the B–47 is standard equipment with the U.S.A.F.

The thin laminar-flow wing section, while ensuring low drag, incurs the penalties of extreme flexibility and lack of internal stowage. The wing is so pliant that in level flight it flexes several feet, and the "podded" arrangement of the jet units is dictated primarily by the thin section of the wing, and the necessity to avoid interference with the wing flow. As neither wing or turbojet pods offer stowage space for the main undercarriage members, the two main twin-wheel units retract fore and aft of the bomb-bay in the large, oval-section fuselage.

Basic design work on the Boeing Model 450 was completed in June 1946, and the first of two prototypes designated XB–47 flew on December 17, 1947, powered by six 3,750 lb. thrust Allison J35–A turbojets. The Allison engines were later replaced by six 5,000 lb. thrust General Electric J47–GE–3 units, the re-engined XB–47 flying on October 7, 1949.

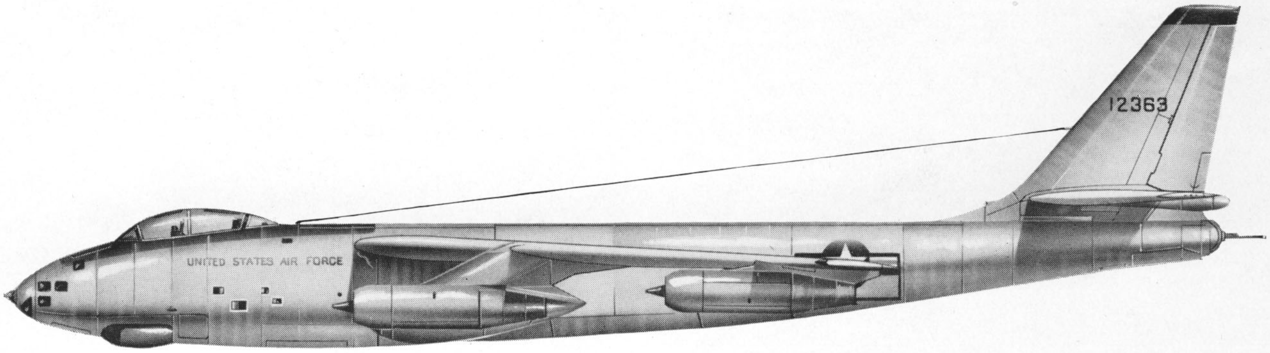
In November 1948 a contract was awarded for ten B–47A pre-production aircraft powered by 5,200 lb. thrust J47–GE–11 turbojets, and the first B–47A was completed on March 1, 1950. The first major production model, the B–47B, embodied a number of structural modifications, including wing strengthening, and the first eighty-seven B–47Bs were powered by J47–GE–11 turbojets similar to those of the A sub-type. The eighty-eighth and subsequent B–47Bs had the more powerful J47–GE–23 of 5,800 lb. thrust. The first B–47B flew on April 26, 1951. Initial design maximum gross weight had been 125,000 lb., but with structural strengthening, equipment changes and increased fuel tankage this was increased to a permissible in-flight gross weight of 202,000 lb.

The B–47B can be adapted to perform the photo-reconnaissance role under the designation RB–47B by the installation of a self-contained camera housing in the bomb-bay. A projected development powered by four 9,400 lb. thrust Allison J71–A–5 turbojets and designated B–47C was abandoned, but two XB–47D prototypes, which have the inboard pairs of J47 turbojets replaced by single 9,500 e.s.h.p. Wright YT49–W–1 turboprops, have been built as high-altitude test-beds for turboprop engines and supersonic airscrews.

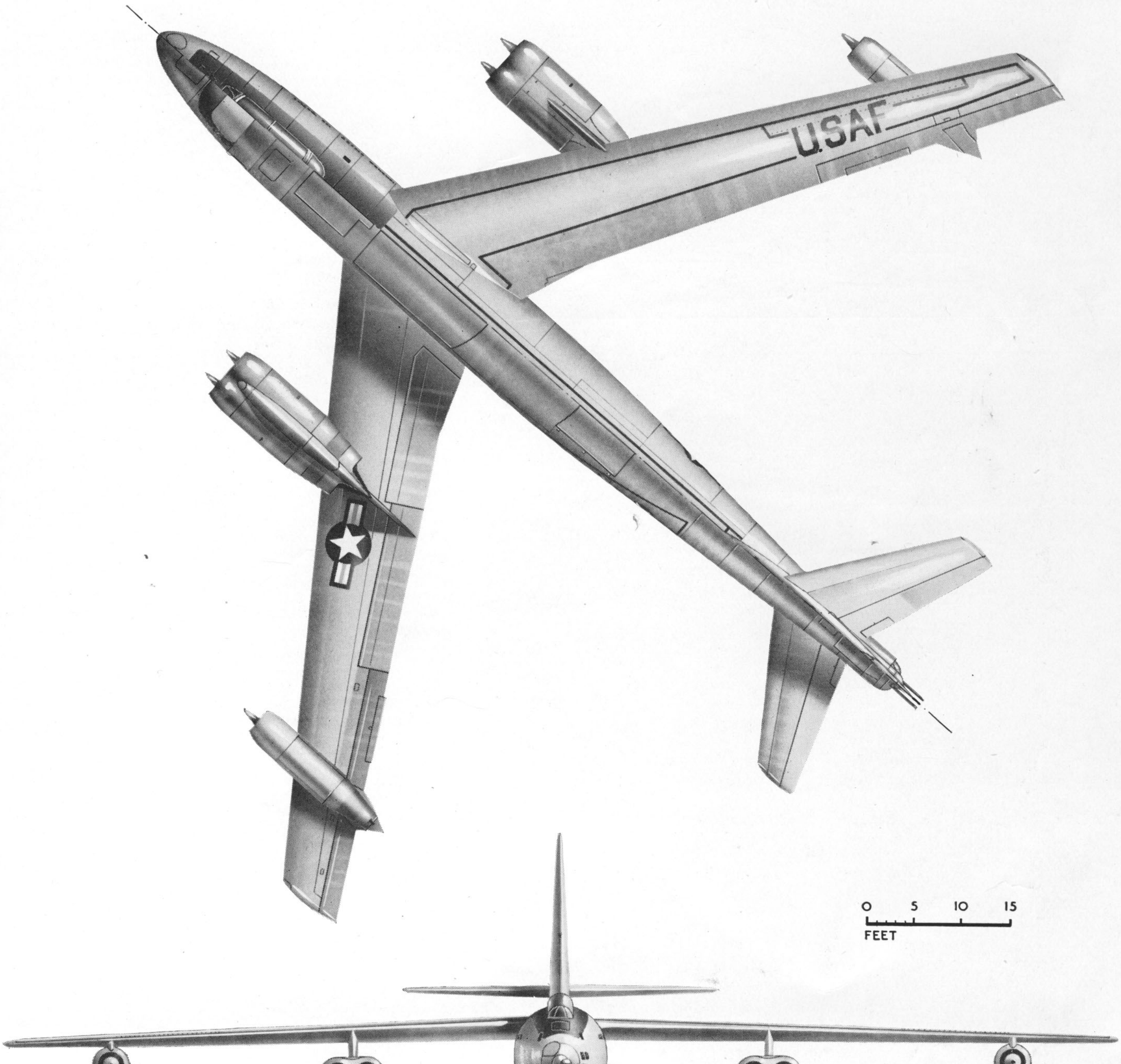
The current production version of the Stratojet is the B–47E which, powered by six 6,000 lb. thrust (7,200 lb. with water injection) J47–GE–25 engines, is outwardly indistinguishable from the earlier B–47B apart from the installation of a radar-directed twin 20-mm. gun position in the tail. The B–47E flew for the first time on January 30, 1953, and radio-controlled drone and crew-trainer variants are designated QB–47E and ETB–47E respectively. A specialised photo-reconnaissance variant has an extended fuselage nose which increases overall length to 112 ft. 8 in. This nose section contains a heated and air-conditioned camera compartment, and very complete reconnaissance equipment is carried.

The B–47E carries an operational crew of three: pilot, co-pilot and bombardier/navigator. The internal bomb-bay was designed to house a maximum bomb load of 20,000 lb., and the only defensive armament comprises two 20-mm. guns in the tail. The complete fire-control system and turret are installed as a detachable pod, and the unit provides automatic warning of approaching aircraft, tracks, positions, and fires the guns when the target comes within range. Normal maximum speed is 630–640 m.p.h., but on one occasion, during a 1,000-hr. test programme, a B–47E averaged 794 m.p.h. for 30 min. with the aid of a tail wind.

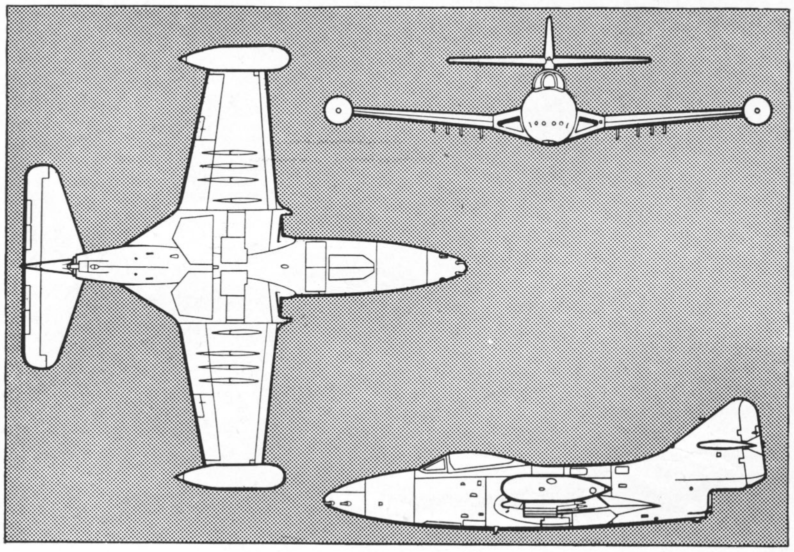
All production B–47E Stratojets are fitted with the Boeing-developed flying-boom type in-flight refuelling equipment in the nose, and an air-refuelled B–47 recently established a jet aircraft endurance record by remaining in the air 35 hrs., during which time a distance of 17,000 miles was flown. Without recourse to in-flight refuelling the B–47E has a range (with an unspecified bomb load) exceeding 3,000 miles, and this can be extended by the addition of two 1,482 Imp. gal. fuel tanks attached under the wing. Overall dimensions are: span, 116 ft.; length, 106 ft. 8 in.; height, 27 ft. 11 in.



BOEING B-47E STRATOJET



The Grumman F9F–2 Panther (above, left) *and F9F–5* (above, right, and drawing) *with lengthened fuselage and enlarged vertical tail surfaces.*



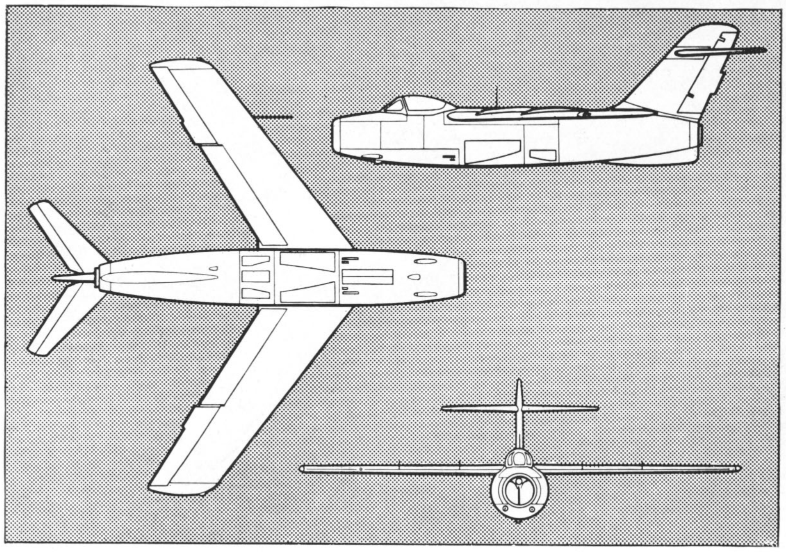
GRUMMAN PANTHER (NOVEMBER) 1947

Originally designed around four 1,600 lb. thrust Westinghouse J30–WE–20 turbojets clustered in its wing roots and designated XF9F–1, the Grumman single-seat carrier-borne fighter was entirely re-designed in 1946 to take a single 5,000 lb. thrust Rolls-Royce Nene, the first of two Nene-powered (Model G–79) XF9F–2 prototypes flying on November 24, 1947.

The first production model, the F9F–2, powered by a 5,000 lb. thrust Pratt and Whitney J42–P–6 (licence-built Nene), flew on November 24, 1948. Later production machines had the J42–P–8 (5,750 lb. thrust with water injection), providing the F9F–2 with a top speed of 572 m.p.h. (dry power) and an initial climb rate of 6,000 ft./min. A total of 437 F9F–2 Panthers was delivered to the U.S.N. and U.S.M.C.

On August 16, 1948, a further prototype, the XF9F–3, flew with a 4,600 lb. thrust Allison J33–A–8, fifty-four Allison-powered F9F–3s being ordered. The first F9F–3 flew on November 23, 1948, but all were later converted to F9F–2s. The F9F–4 featured a 2-ft. increase in fuselage length, and a 6,350 lb. thrust Allison J33–A–16A, which raised top speed to 633 m.p.h. Seventy-three were ordered but eventually incorporated into F9F–5 orders.

The final production model, the F9F–5, first flew on December 21, 1949, and 641 were delivered, consecutive production batches having J48–P–2, –4, and –6A turbojets of 6,250 lb. thrust, and 7,000 lb. with water injection. The F9F–5 had a top speed of 623 m.p.h. and climbed to 40,000 ft. in 10 min. Empty and loaded weights were 8,660 lb. and 17,000 lb. Dimensions were: span, 38 ft.; length, 42 ft.; height, 16 ft.



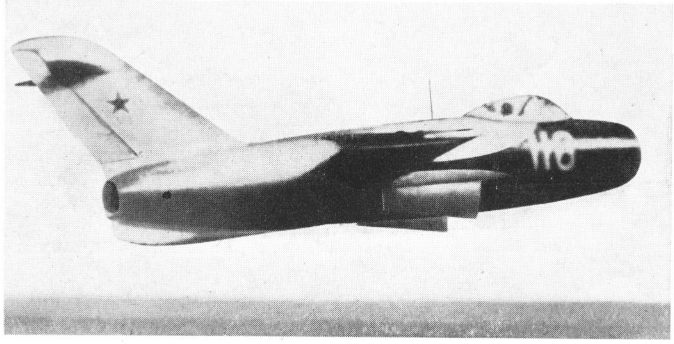
LAVOCHKIN (TYPES 15 & 21) (LATE) 1947

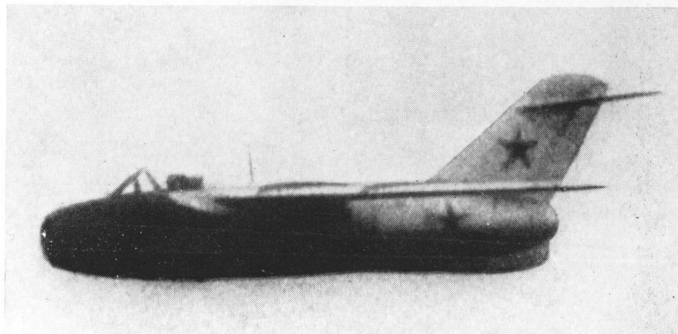
Contemporary to the MIG–15 and credited to Semyon A. Lavochkin, this single-seat fighter has been allotted the identification type numbers " 15 " *and* " 21 " by the N.A.T.O. air forces, but has been widely referred to by the uncorroborated designation " LA–17 ". The existence of this fighter was known in the West in 1948, and the type was displayed publicly during the Soviet Aviation Day celebrations of 1949.

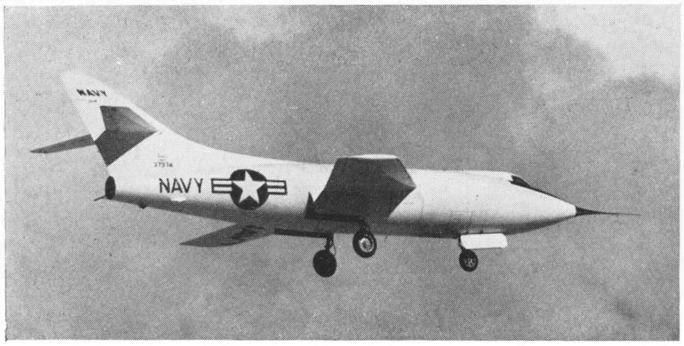
Initial production machines did not possess the long ventral fin, or " keel ", and wing fences that characterised later production machines, and these received the appellation " Type 15 ". The later model is known as the Type 21. Employing a straight-through jet-flow arrangement with a simple, circular nose intake leading air to the centrifugal-type turbojet, the Lavochkin fighter is considerably larger than is the MIG–15, which fact, together with the designer's previous concentration on medium-range escort fighters, suggests that the Type 21 was intended for tactical bomber escort duties. The shoulder-mounted wing—a layout much favoured by German designers for their late wartime projects—is swept at 30° at the main spar, and all members of the nosewheel undercarriage retract into the fuselage.

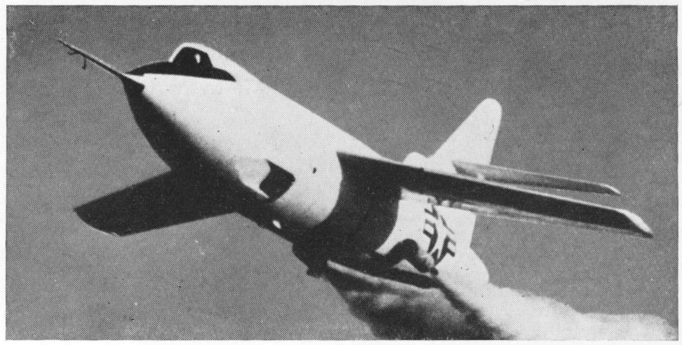
Like the MIG–15, the prototype of the Lavochkin fighter was presumably powered by one of the 4,850 lb. thrust Rolls-Royce Nene turbojets imported from Britain. Production machines were evidently powered by the VK–1 or VK–2 copies of the Nene. Top speed has been estimated at 640 m.p.h., and span and length are approximately 37 ft. and 40 ft. respectively.

The Type 21 single-seat fighter is distinguished by its comparatively high aspect ratio shoulder-mounted wing, and the generous area of its vertical tail surfaces.



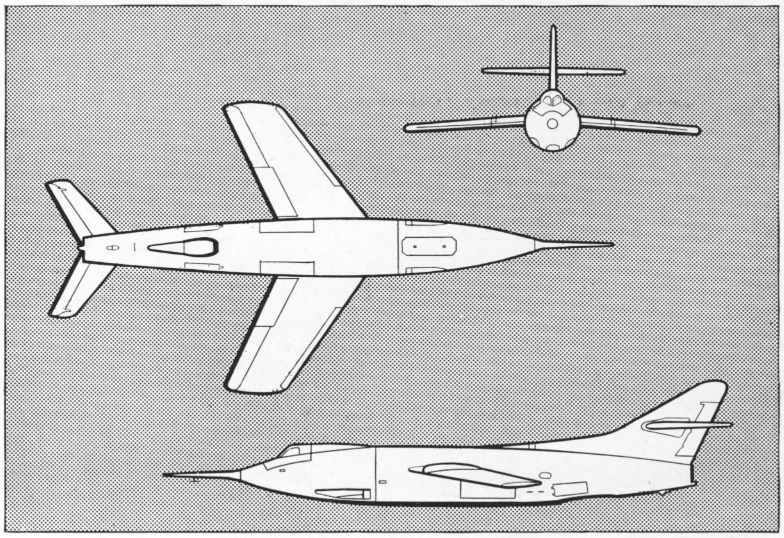






The D–558–2 Skyrocket was the first aircraft to fly at twice the speed of sound. (Above, right) *A Skyrocket takes off with the aid of auxiliary rockets.*

DOUGLAS SKYROCKET (FEBRUARY) 1948

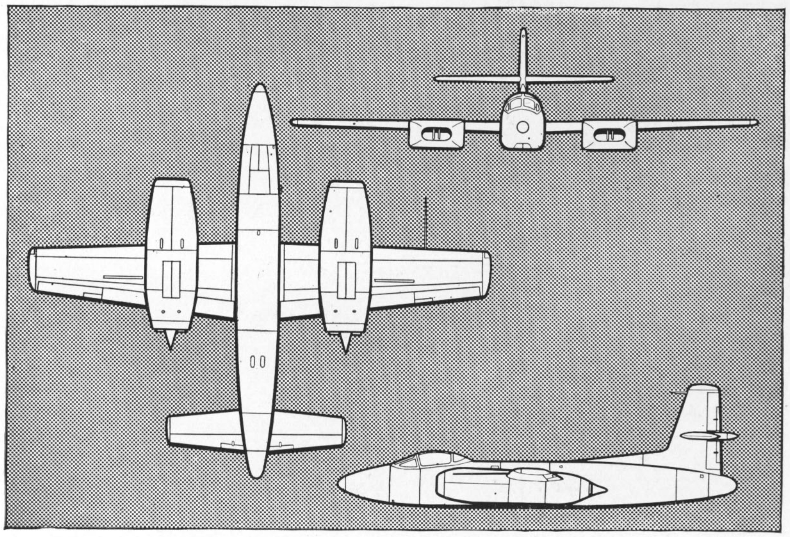


Designed in collaboration with the N.A.C.A. under contract to the U.S. Navy, development of the D-558-2 was initiated in the summer of 1945, and the first of three research aircraft of this type flew on February 4, 1948. Originally intended as a version of the D-558-1 Skystreak with 35° wing sweep, it was decided that the full advantages of the sweptback wing could not be obtained on the power of existing turbojets, and the 3,000 lb. thrust Westinghouse J34-WE-22 turbojet, which provided power for take-off and climb to altitude, was supplemented by a 6,000 lb. thrust Reaction Motors XLR-8 bi-fuel rocket unit in the tail.

In this form, a Skyrocket exceeded Mach 1·0 on October 14, 1947, and in May 1949 attained Mach 1·05 at 25,000 ft. (approx. 730 m.p.h.). In August 1951, one Skyrocket had the turbojet removed and its rocket fuel capacity doubled, and on August 21, 1951, after being carried to 35,000 ft. by a Boeing P2B-1, it climbed to 68,000 ft., at which altitude it attained Mach 1·7 (1,143 m.p.h.), and a week later Mach 1·875 (1,238 m.p.h.). On August 21, 1953, a Skyrocket was released from its carrier aircraft at 34,000 ft. and climbed to 83,235 ft., and on October 14, 1953 attained Mach 1·96 (1,272 m.p.h.).

On November 21, 1953, the Skyrocket became the first piloted aircraft to fly at twice the speed of sound, attaining Mach 2·01 at 65,000 ft. (1,327 m.p.h.) These performances are particularly noteworthy in view of the fact that the Skyrocket employs a conventional subsonic aerofoil, and was designed to attain Mach 1·4. The overall dimensions of the Skyrocket are: span, 25 ft.; length, 45 ft. 3 in.; height, 11 ft. 6 in.

CURTISS NIGHTHAWK (FEBRUARY) 1948



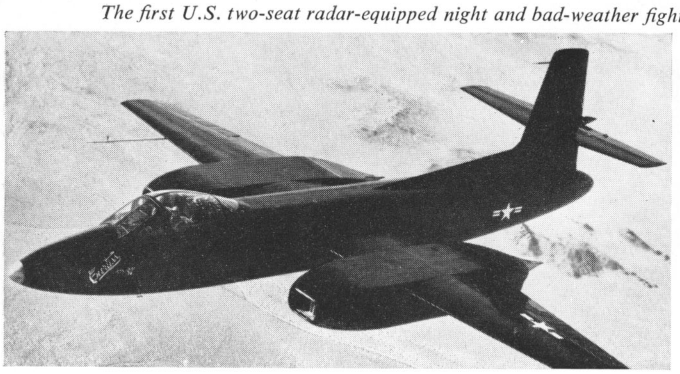
An exceptionally large and heavy experimental fighter, the Curtiss XF-87 Nighthawk was the first U.S. multi-seat jet combat aircraft intended for use as a radar-equipped all-weather fighter. The XF-87 was intended for two 5,200 lb. thrust General Electric J47-GE-15, but as these units were not available for installation the prototype flew on February 15, 1948, powered by four 3,200 lb. thrust Westinghouse J34-WE-30 turbojets paired in two large wing-mounted nacelles.

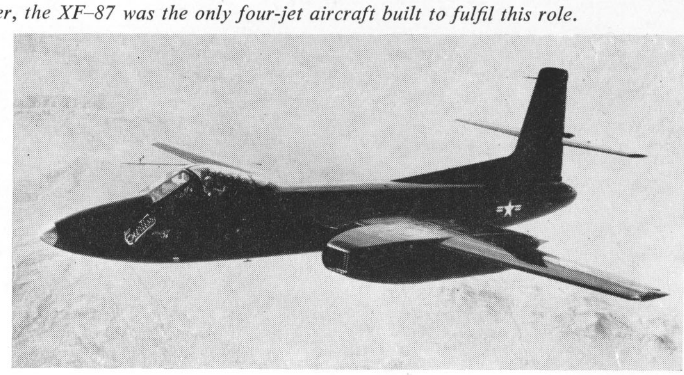
Carrying a crew of two—pilot and radar-operator seated side by side under a bubble-type canopy well ahead of the wing and engine nacelles—and weighing more than 30,000 lb., the XF-87 had a 65-ft. oval-section fuselage and a mid-positioned wing spanning 60 ft. and mounted well aft on the fuselage. The two jet nacelles were of rectangular cross-section.

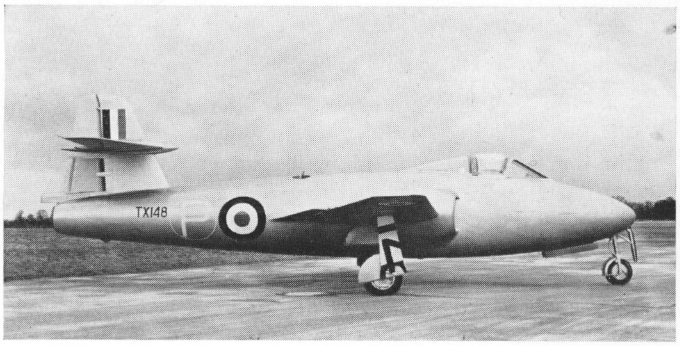
A production order was placed for fifty-eight F-87 Nighthawk all-weather fighters and thirty RF-87A photo reconnaissance aircraft powered by J47 turbojets. Comprehensive search and navigation radar were to be fitted in the nose, and a built-in armament of 0·5-in. or 20-mm. guns was to be carried. However, the extensive design changes caused by the power-plant change necessitated construction of a further prototype, and the resulting delays led to the cancellation of production orders in favour of the Northrop XF-89 Scorpion, so that further development of the XF-87 Nighthawk was abandoned.

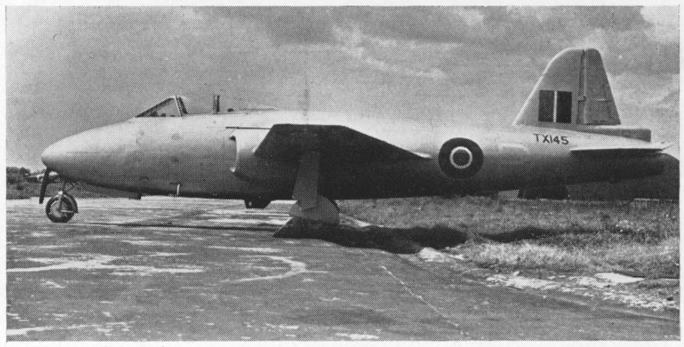
The projected production model of the Nighthawk had an estimated maximum speed of 585 m.p.h., and maximum range exceeding 2,000 miles.

The first U.S. two-seat radar-equipped night and bad-weather fighter, the XF–87 was the only four-jet aircraft built to fulfil this role.

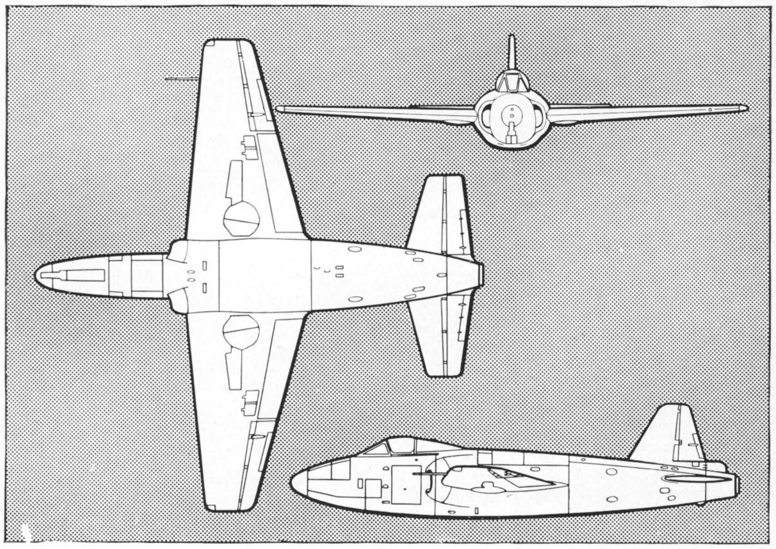








The third prototype G.42, TX148 (above, left), *had similar tail assembly to Meteor F.8. The second G.42, TX145* (above, right, and drawing), *differed only in tail arrangement.*



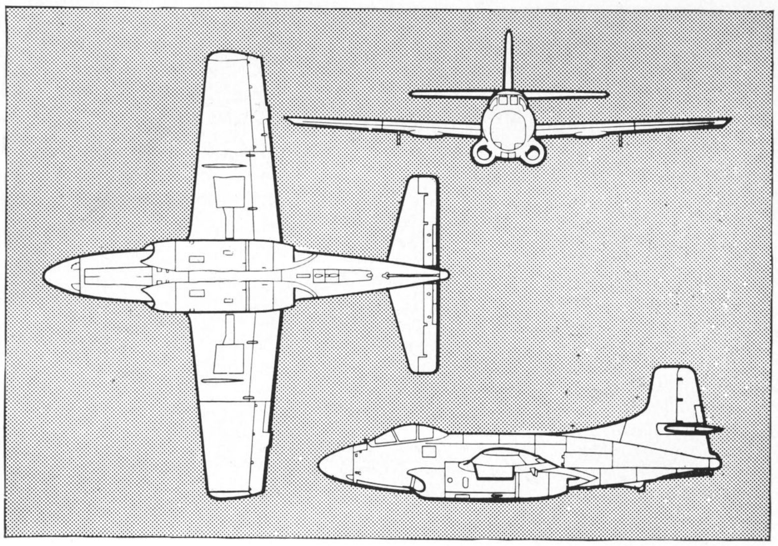
GLOSTER G.42 (E.1/44) (MARCH) 1948

Intended to meet specification E.1/44, the Gloster G.42 single-seat interceptor fighter was designed around a 5,000 lb. thrust Rolls-Royce Nene R.N.2 turbojet and was, in effect, an attempt at the smallest efficient airframe capable of accommodating the turbojet, pilot, armament and necessary equipment.

Its salient features were a mid-positioned wing, an exceptionally broad fuselage and an undercarriage of unusually wide track. The wing featured marked taper on leading and trailing edges, and carried dive-recovery flaps and inboard air brakes. The Nene turbojet was fed by means of lateral air intakes, and the fuselage housed a total of 428 Imp. gal. fuel, which was sufficient for a range of some 750 miles. This could be supplemented by underwing drop-tanks. Fixed armament comprised four 20-mm. Hispano cannon, and provision was made for underwing loads of two 1,000-lb. bombs or eight 90-lb. rocket missiles.

The first prototype G.42 was to have flown in August 1947 but was irreparably damaged while in transit to Boscombe Down. Flight testing was thus delayed until the completion of the second prototype, which flew on March 9, 1948. This was followed by a third G.42 with revised tail surfaces. Several pre-production machines were partly completed, and a projected swept-wing variant was allotted the specification E.23/46, but no further machines were flown.

The G.42 had a maximum speed of approximately 635 m.p.h. at sea level, and initial climb rate exceeded 5,000 ft./min. Dimensions were: span, 36 ft.; length, 38 ft.; height, 11 ft. 8 in.; wing area, 254 sq. ft.



DOUGLAS SKYKNIGHT (MARCH) 1948

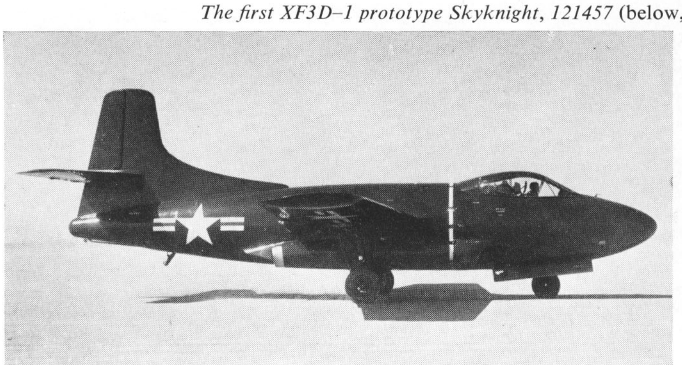
The first two-seat carrier-borne jet night fighter to be adopted by the U.S. Navy, the first of two XF3D-1 prototype Skyknights flew on March 23, 1948, and the second on August 7, 1948, powered by two 3,000 lb. thrust Westinghouse J34-WE-22 turbojets mounted semi-externally on the lower fuselage, beneath the mid-positioned wing and exhausting through skewed tailpipes.

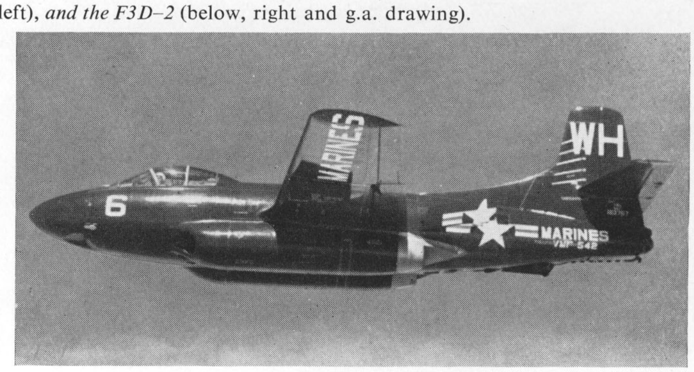
In June 1948, the U.S. Navy ordered twenty F3D-1 production Skyknights powered by 3,000 lb. thrust J34-WE-32 units, the first flying on February 13, 1950. The F3D-1 weighed 17,200 lb. empty and 27,362 lb. loaded. Maximum speed was 530 m.p.h. at sea level and 425 m.p.h. at 40,000 ft. Initial climb rate and combat radius were 1,960 ft./min. and 600 miles respectively.

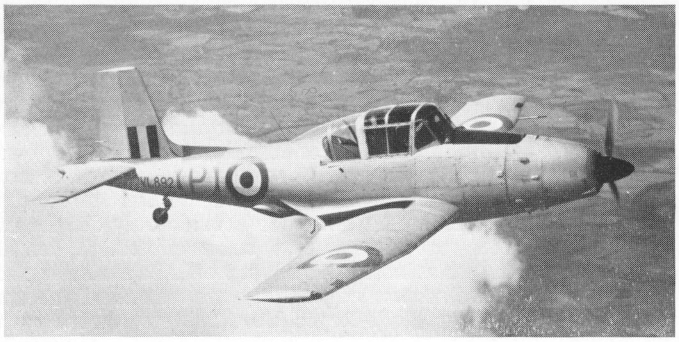
An improved model, the F3D-2, was designed for two 4,800 lb. thrust Westinghouse J46-WE-3 turbojets, and this version differed externally from its predecessor in having enlarged engine nacelles. However, development difficulties with the J46 led to the installation of 3,400 lb. thrust J34-WE-36 units which retained the larger nacelles. Seventy F3D-2 Skyknights were delivered. These carried APG-35 radar and an armament of four 20-mm. cannon. A further development, the XF3D-3, embodying a swept wing, was projected, but an order for 102 F3D-3s was cancelled in February 1952.

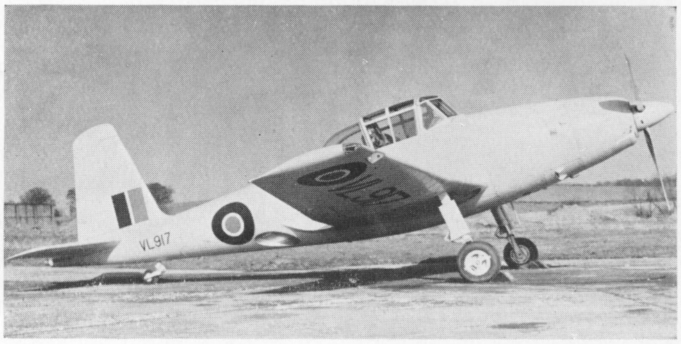
The F3D-2 had empty and loaded weights of 18,160 lb. and 27,000 lb. respectively, and overall dimensions were: span, 50 ft.; length, 45 ft. 5 in.; height, 16 ft. 6 in.

The first XF3D–1 prototype Skyknight, 121457 (below, left), *and the F3D–2* (below, right and g.a. drawing).









The first prototype Balliol VL892, or P.108, was originally piston-engine-powered and later re-engined with a Mamba turbojet (above, left). *The first Mamba-powered Balliol VL917 is illustrated* (above, right).

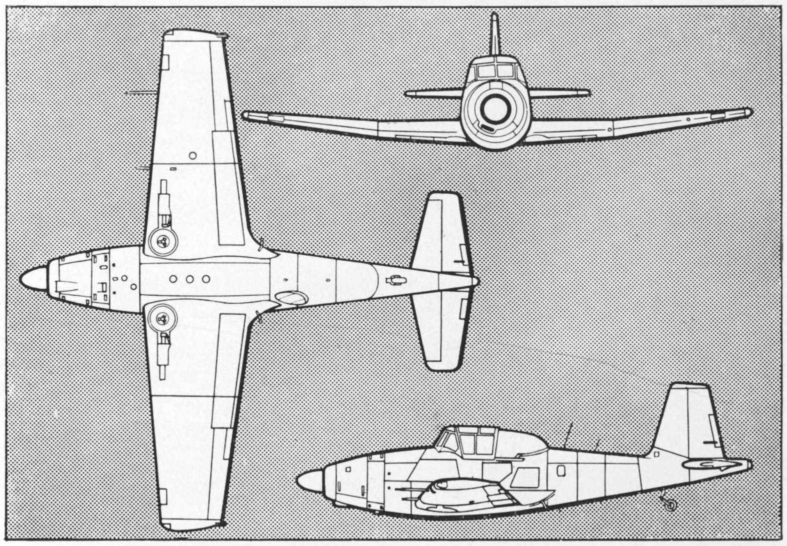
BOULTON PAUL BALLIOL (MARCH) 1948

The Balliol was the world's first turboprop-powered training aircraft to fly, having flown for the first time on March 24, 1948, on the power of a 1,135 e.s.h.p. Armstrong Siddeley Mamba A.S.Ma.1. Designed to fulfil specification T.7/45 calling for a turboprop-powered three-seat advanced trainer, the Balliol was first flown, as the P.108, on May 30, 1947, with a Bristol Mercury 25 piston-engine, the Mamba turboprop not then being ready for installation. A considerable amount of flying experience was gained with the P.108, and the piston-engine was replaced by a Mamba in 1952. A second Balliol T.1 was flown on May 17, 1948.

Changes in R.A.F. training requirements precluded production of the three-seat Mamba-powered Balliol T.1, the basic design being adapted for the 1,280 h.p. Rolls-Royce Merlin 35 piston-engine to fulfil the requirements of specification T.14/47.

The Balliol T.1 weighed 5,732 lb. empty and 7,845 lb. loaded. Maximum speed was 307 m.p.h. at 20,000 ft., and maximum continuous cruising speed was 272 m.p.h. Service ceiling was 36,750 ft., and endurance at maximum continuous cruising speed at 10,000 ft. was 2 hr. 30 min. Overall dimensions were: span, 39 ft. 4 in.; length, 36 ft. 6 in.; height, 10 ft. 7 in.; gross wing area, 250 sq. ft.

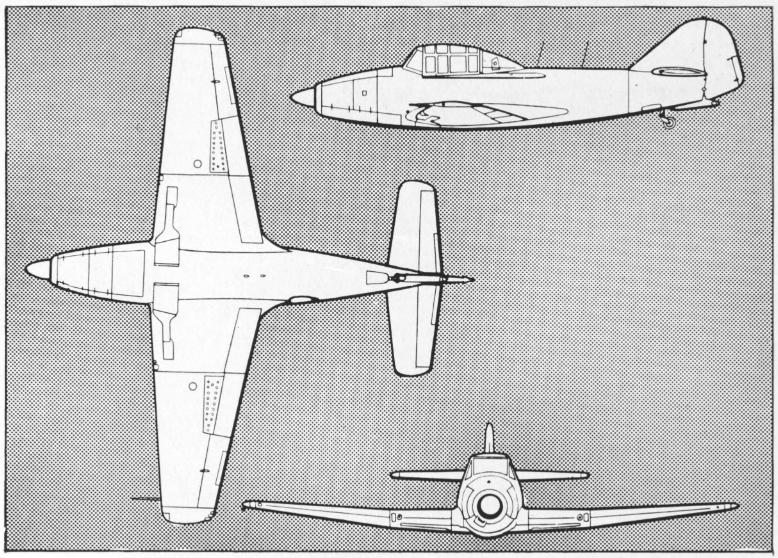
The Balliol T.1 had side-by-side seating for instructor and pupil with full dual control, and a third seat at the rear of the cockpit for the observer. Construction was all-metal, and the 320 lb. residual thrust of the Mamba turboprop was led below the cockpit floor to an orifice in the starboard fuselage side.



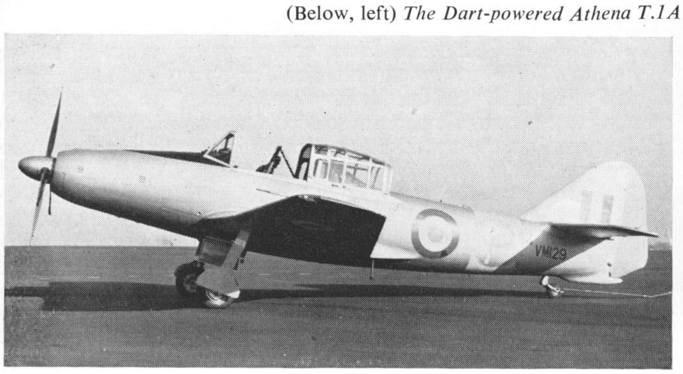
AVRO TYPE 701 ATHENA (JUNE) 1948

The Avro Athena was originally designed to meet the requirements of specification T.7/45 calling for a three-seat advanced trainer powered by a turboprop power plant. Two turboprop versions of the Athena trainer were developed, the Marks T.1 and T.1A, and two prototypes of the former and one of the latter were produced. The first prototype, the Athena T.1, was powered by a 1,135 e.s.h.p. Armstrong Siddeley Mamba A.S.Ma.1 and flew for the first time on June 12, 1948, and the Athena T.1A was powered by a 1,125 e.s.h.p. Rolls-Royce Dart R.Da.1. However, no series production of the turboprop-powered Athena was undertaken, the design being modified to meet specification T.14/47 and seventeen pre-production Athena T.2s were built powered by the Rolls-Royce Merlin 35 piston-engine. The decision to utilise the piston-engine in place of the turboprop was governed by engine availability.

A noteworthy feature of the design of the Athena was the excellent view over the nose resulting from the tapered cowling of the turboprop. Provision was made for the attachment of two 45 Imp. gal. underwing drop-tanks. Apart from power plant, the Athena T.1A differed from the T.1 in having Mk.2 outer wings with revised dive brakes and other modifications which characterised the Merlin-powered Athena T.2. The Athena T.1 had a maximum speed of 287 m.p.h. at 10,000 ft., a cruising speed of 253 m.p.h., and an intial climb rate of 2,630 ft./min. Empty and loaded weights were 5,067 lb. and 7,191 lb. respectively, and overall dimensions were: span, 40 ft.; length, 36 ft. 6 in.; height, 12 ft. 11 in.; gross wing area, 270 sq. ft.



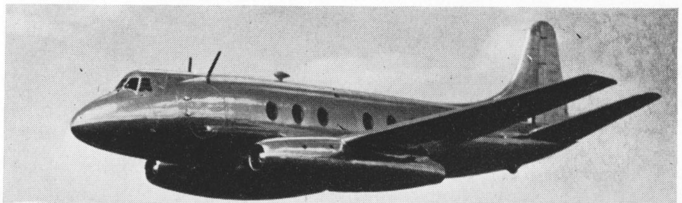
(Below, left) *The Dart-powered Athena T.1A and* (right) *the Mamba-powered Athena T.1.*



VICKERS VISCOUNT

The JET AIRCRAFT of the World (JULY) 1948

(Above) *The Type 630 Viscount.* (Below) *The Type 663 Viscount.*



(Above) *Prototype 700 series Viscount (G–AMAV).*
(Below) *Viscount 701 (G–AMOC).*

(Above) *Viscount 708 of Air France.* (Below) *Viscount 707 of Aer Lingus.*

When the Type 630 Viscount flew on July 16, 1948, it became the first commercial turboprop-powered aircraft in the world to fly. Design studies had commenced in 1945 for a medium-range airliner to meet the Brabazon IIB Specification, and, initially known as the Type 609 Viceroy, an order for two prototypes was placed in 1946. When design studies were started the Dart turboprop chosen for the project was expected to provide only 800 s.h.p., and a twenty-four-seat aircraft was contemplated. When it became apparent that at least 1,000 s.h.p. would be available, the design was revised to accommodate thirty-two seats. In this form and powered by four Rolls-Royce Dart 502 turboprops each providing 1,125 e.h.p. (1,000 s.h.p. plus 300 lb. residual thrust), the first prototype flew as the Type 630 Viscount.

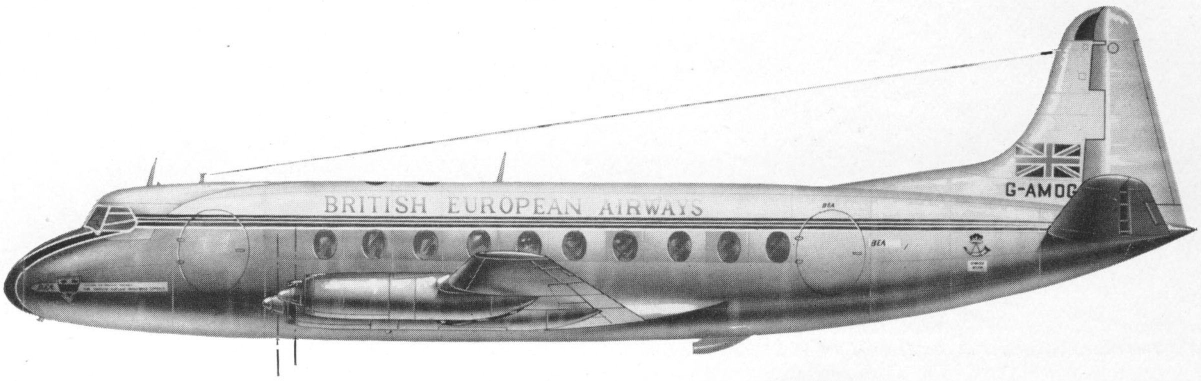
By the end of 1947 it had already been decided that the payload of the Type 630 might be inadequate for the European routes, and, as the Dart appeared likely to offer considerable increases in power, an enlarged version of the Viscount was projected. Featuring a 6 ft. 8 in. increase in fuselage length and a 5 ft. increase in wing span, take-off weight was to rise from 45,000 to 48,000 lb. and alternative layouts for forty or fifty-three seats were to be provided. The second Viscount prototype had meanwhile been diverted to military development work and, with two 6,250 lb. thrust Rolls-Royce Tay R.Ta.1 turbojets, flew on March 15, 1950, as the Type 663. The third prototype Viscount, the Type 700, was flown on August 28, 1950, powered by four Dart 504 (R.Da.3) turboprops rated at 1,530 e.h.p. (1,400 s.h.p. plus 365 lb. thrust), and a contract for twenty machines was placed by British European Airways.

The Viscount 700 series has since been ordered by several of the world's airlines: the Type 701 for B.E.A.; the Type 702 for British West Indian Airways; the Type 707 for Aer Lingus; the Type 708 for Air France; the Type 720 for Trans-Australia Airlines; the Types 724 and 757 (700D series) for Trans-Canada Airlines; Types 723 and 730 (700D series) for the Indian Air Force; the Type 735 for Iraqi Airways; the Type 732 and 759 for Hunting-Clan Air Transport; the Type 736 for Fred Oslen Air Transport; the Type 737 for the Canadian Department of Transport; the Type 739 for Misrair; the Type 742 for Braathens S.A.F.E.; the Types 744 and 745 (700D series) for Capital Airlines; the Type 747 for Butler Air Transport; the Type 748 for Central African Airways; the Type 749 (700D series) for Linea Aeropostal Venezolana; and the Type 755 for Hong Kong Airways. All these types are substantially the same, differing (apart from the 700D) only in accommodation and equipment to suit individual operators.

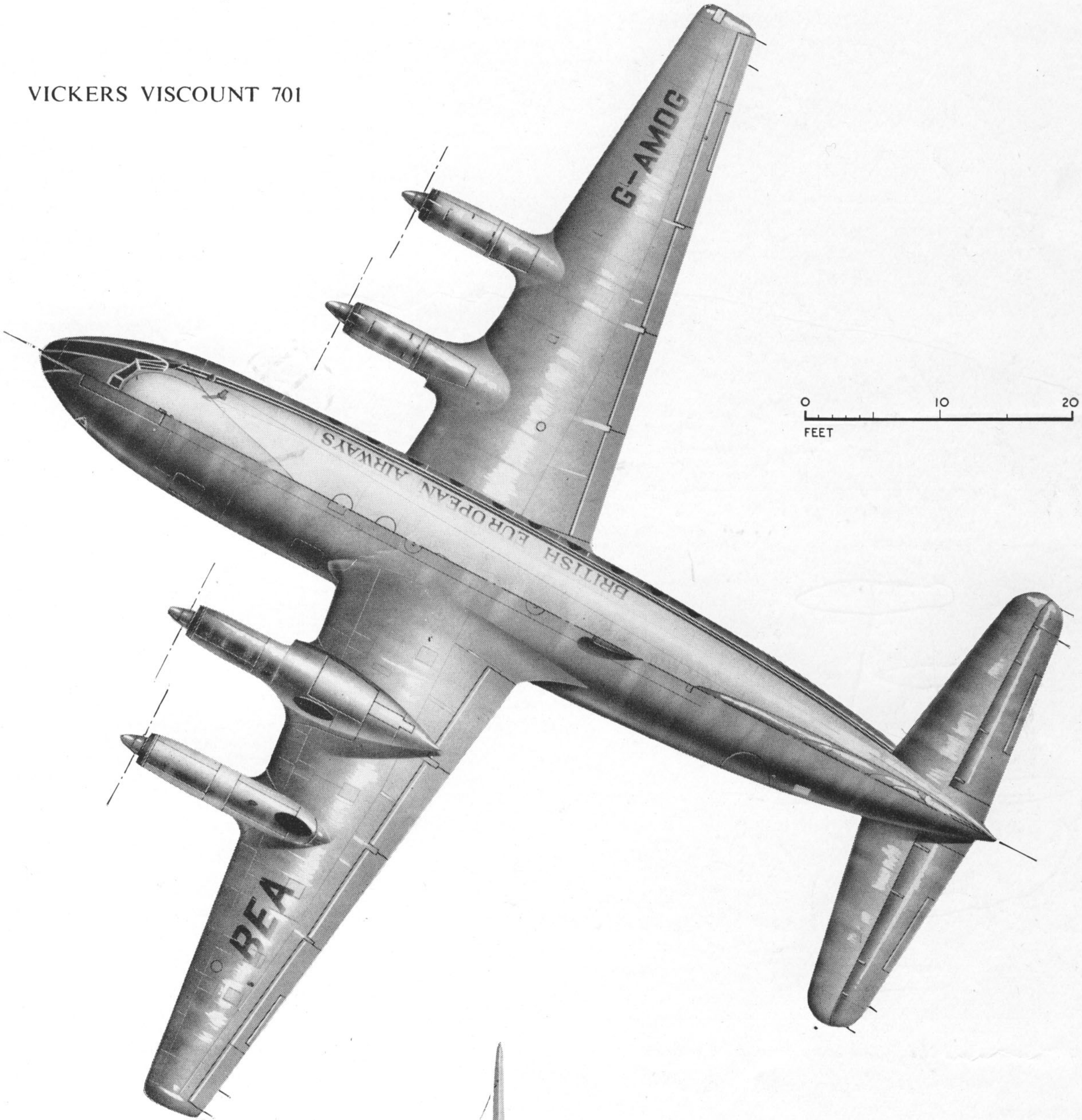
The Viscount 700 series normally accommodates forty to forty-eight passengers and has a maximum payload of 12,700 lb. Empty and loaded weights are 34,358 lb. and 58,500 lb. respectively, and the fuel capacity of 1,720 Imp. gal. provides a maximum still-air range (with maximum payload) of 1,400 miles, and (with 9,400 lb. payload) 1,910 miles. Average cruising speed is 320 m.p.h., and overall dimensions are: span, 93 ft. 8½ in.; length, 81 ft. 2 in.; height, 26 ft. 9 in.; wing area, 963 sq. ft.

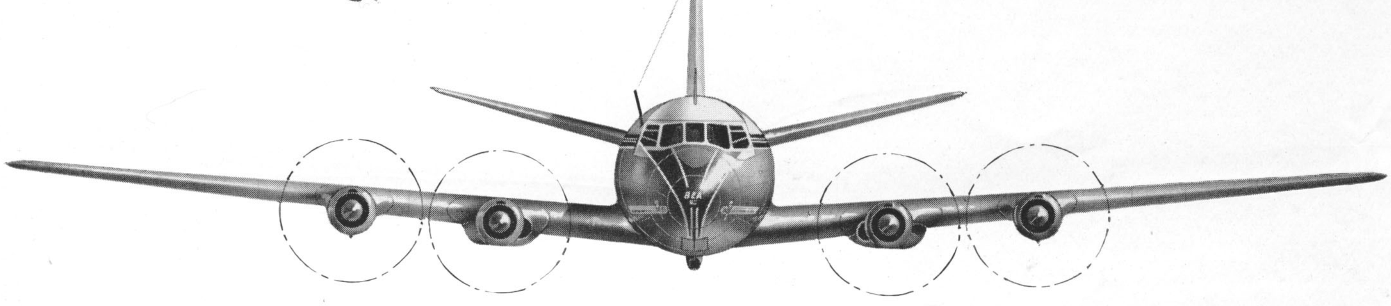
A progressive development of the Viscount is the Series 700D, which retains the basic fuselage and passenger capacity of the earlier 700 series, but offers higher performance. Powered by four Dart 510 (R.Da.6) engines of 1,690 e.h.p. (1,550 s.h.p. and 365 lb. thrust), the Viscount 700D has maximum loaded weight increased to 62,000 lb. and internal fuel capacity increased to 1,950 Imp. gal., providing a maximum still-air range of 1,450 miles. By the use of two 145 Imp. gal. "slipper" tanks, which can be attached to the outboard wing sections, maximum still-air range with capacity payload is increased to 1,655 miles.

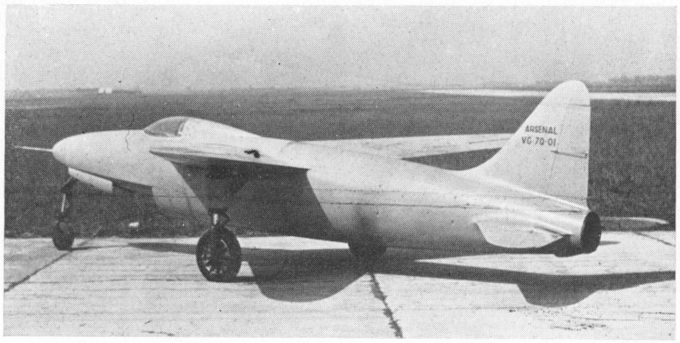
Early in 1953 British European Airways ordered twelve Viscount 801s which were intended for short-haul duties and identified by a 12 ft. 4 in. fuselage extension. The Viscount 801 was to have provided accommodation for sixty-six to eighty-two passengers, but the specification has since been revised and the increase in fuselage length as compared to the 700 series reduced to 3 ft. 10 in. ahead of the wing. Coupled with the repositioning of the forward bulkhead, this will enable the Type 802, as the "stretched" Viscount has been designated, to carry two more rows of seats, capacity thus being increased to a maximum of seventy tourist-class passengers. Like the Viscount 700D, the 802 will be powered by four Dart 510 turboprops, and empty and loaded weights (max.) are, 38,797 lb. and 62,000 lb. respectively.

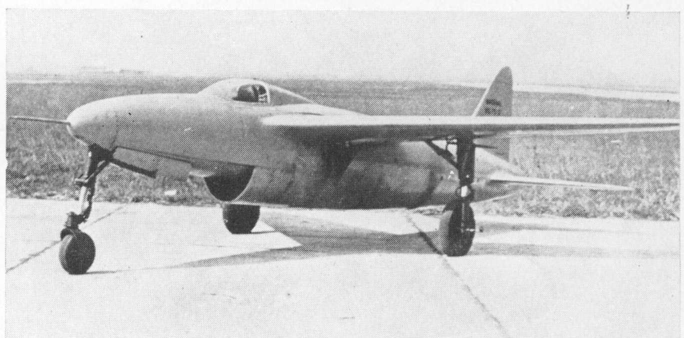


VICKERS VISCOUNT 701

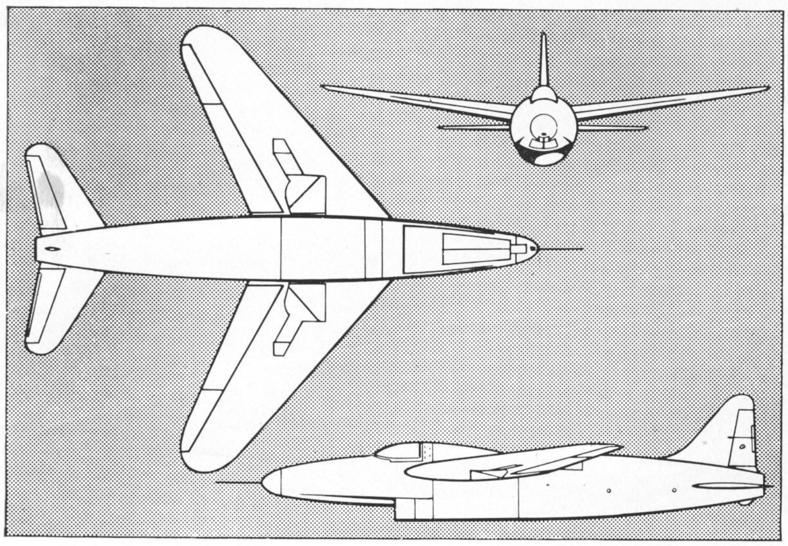








Noteworthy features of the Arsenal VG 70 shown by the drawing and photographs are the pronounced wing dihedral and ventral intake.

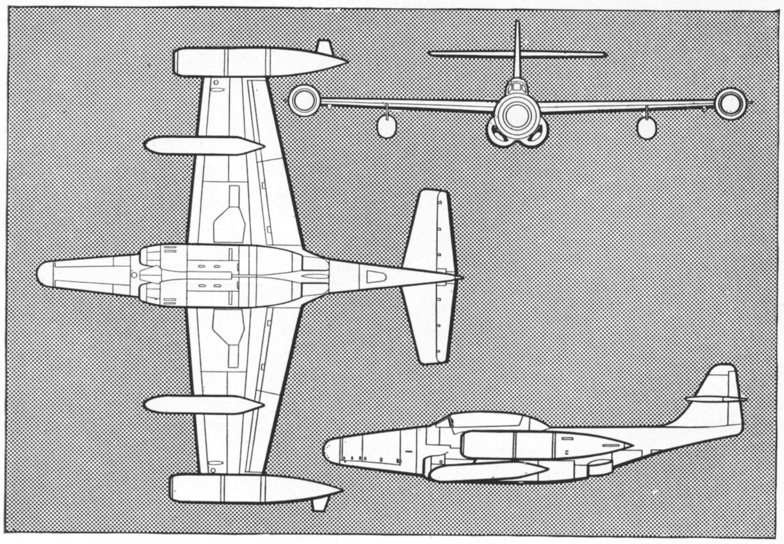


ARSENAL VG 70 (JUNE) 1948

The VG 70 single-seat research aircraft was designed by M. Galtier of the Arsenal de l'Aéronautique shortly after France's liberation when the only suitable turbojet available in France was the German Junkers Jumo 004B–2 of 1,890 lb. thrust. The low thrust provided by this turbojet made it necessary to keep the overall dimensions of the VG 70 as small as possible in order to obtain high performance.

Of metal construction, the fuselage of the VG 70 had a diameter only slightly greater than that of the jet pipe, and the turbojet was fed via an unusual ventrally-positioned sharp-edged scoop. The wing was of two-spar wooden construction, with elliptical tips and swept back at an angle of 38° at quarter-chord. Pillar-box slots were fitted to the leading edge in front of the ailerons. The tailplane was also swept, and the elevator trimmers were of solid wood.

Aerodynamic problems which arose during wind-tunnel testing led to considerable delay in commencing the flight test programme, and the VG 70 was not flown until June 23, 1948. Despite the low thrust of the Jumo 004B–2 turbojet and the aerodynamic inefficiency of the scoop-type air intake, a speed of 559 m.p.h. was attained in level flight at 22,965 ft. A project to replace the German turbojet with a Rolls-Royce Derwent was abandoned owing to the girth of the centrifugal unit which would have necessitated a complete fuselage re-design. The VG 70 had a loaded weight of 7,480 lb., and wing loading was 40·96 lb./sq. ft. Overall dimensions were: span, 29 ft. 10 in.; length, 31 ft. 9¾ in.; height, 7 ft. 6½ in.; wing area, 182·9 sq. ft.



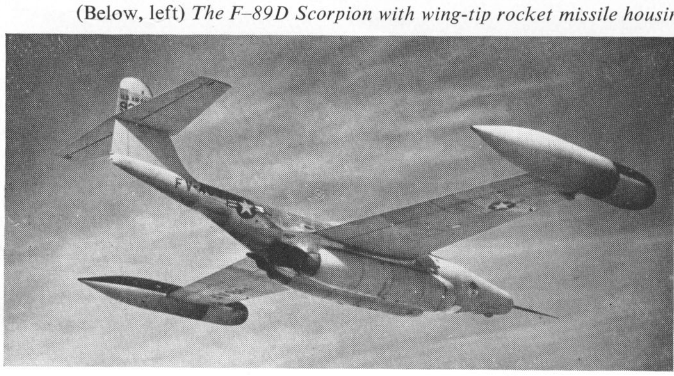
NORTHROP SCORPION (AUGUST) 1948

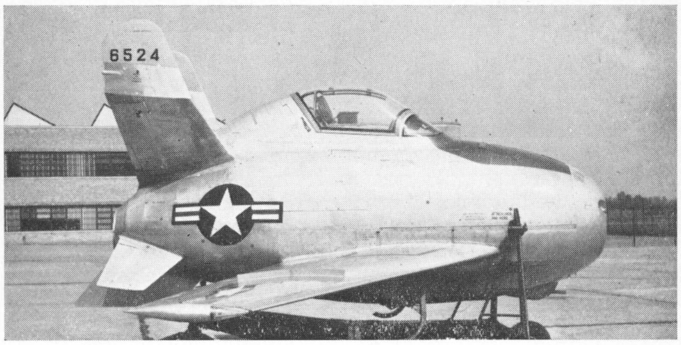
One of the first U.S. multi-seat jet fighters designed specifically for all-weather operation, the Scorpion is a relatively large and complex aircraft featuring a large fuselage of exceptionally high fineness-ratio. The low thickness-ratio of the wing (only 8½ per cent at the root and 7½ per cent at the tip) combined with an aspect ratio of 4·5 : 1 has been claimed to provide an exceptionally low drag-coefficient.

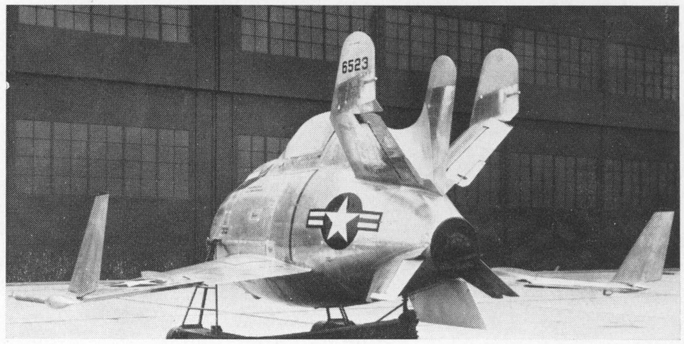
The first of two XF-89 Scorpion prototypes was flown on August 16, 1948, and was followed by forty-eight of the first production model, the F-89A. Powered by two 4,900 lb. thrust Allison J35-A-21 turbojets mounted under the wing on each side of the fuselage, the F-89A attained a maximum speed of 580 m.p.h. and an initial climb rate of 5,500 ft./min. Internal fuel tankage and permanent wing-tip tanks carried 1,140 Imp. gal., providing a maximum range of 2,600 miles. Empty and loaded weights were 19,800 lb. and 32,500 lb. respectively.

The F-89B was generally similar to the F-89A, and the F-89C, of which 150 were built, had 5,000 lb. thrust Allison J35-A-33 turbojets. The F-89D is the final production model with improved electronic gear and two 5,200 lb. thrust Allison J35-A-35 turbojets fitted with Solar afterburners which increase thrust to 7,500 lb. The six 20-mm. cannon armament of earlier models has been replaced by 104 2·75-in. folding-fin rockets in two wing-tip housings. As the DF-89, the Scorpion can carry six Hughes F-98 Falcon missiles under the wing. The YF-89E is powered by two 9,500 lb. thrust Allison YJ71-A-3 engines. The dimensions of the F-89D are: span, 56 ft. 2 in.; length, 53 ft. 4½ in.; height, 17 ft. 7 in.; wing area, 562 sq. ft.

(Below, left) *The F–89D Scorpion with wing-tip rocket missile housings and* (right) *the F–89C with cannon armament and wing-tip fuel tanks.*







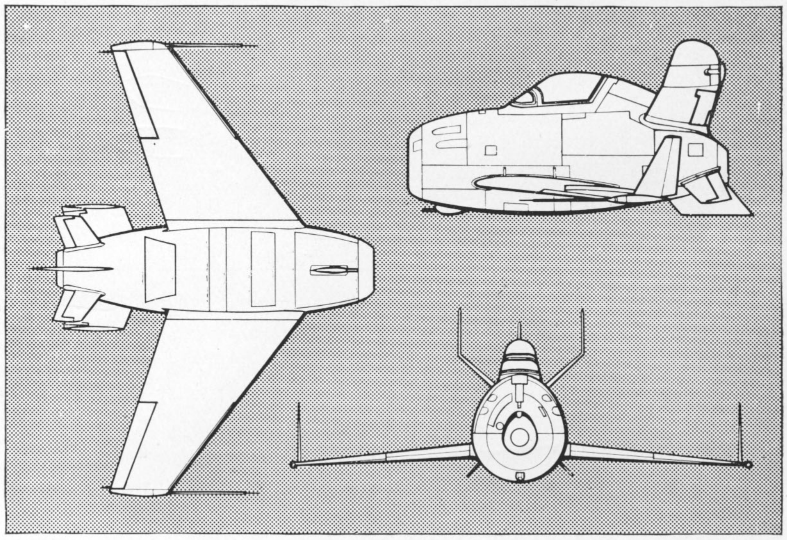
(Above, left) *The second prototype XF–85, 46-524, in its original form without wing-mounted auxiliary fins and* (right), *the first prototype, 46-523, after modification.*

McDONNELL XF–85 (AUGUST) 1948

As the range of the heavy bomber has increased, so has the problem of affording it adequate protection from enemy interception. A potential answer is for the bomber operating beyond the range of conventional fighter escort to *carry* its fighter defence, and the first—and to date the only—jet fighter to be built specifically for use in this way was the XF–85.

Designed for semi-external stowage in the front 16-ft. bomb-bay of the Convair B–36 bomber, the overall dimensions of the XF–85 Goblin were of necessity strictly limited. In order to allow the necessary clearance when being raised or lowered, overall length had to be less than 15 ft. The XF–85 thus became virtually a winged power plant, with the pilot actually straddling the 3,000 lb. thrust Westinghouse J34–WE–22 turbojet. The swept wing was folded before the XF–85 was drawn into the bomb-bay, and in order to avoid folding the tail and obtain the necessary tail area while maintaining the small overall dimensions no fewer than five surfaces were employed. These were mounted radially around the rear fuselage, two carrying combined rudders and elevators. This arrangement was later found to provide inadequate stability and three additional surfaces were provided.

The first of two XF–85s was flown on August 23, 1948, being launched from a modified Boeing B–29. However, failing to engage the trapeze, the pilot was forced to land the XF–85 on its skid at nearly 170 m.p.h. Top speed was approximately 520 m.p.h., and empty and loaded weights were 3,150 lb. and 4,835 lb. respectively. Dimensions: span, 21 ft. $2\frac{3}{4}$ in.; length, 14 ft. $10\frac{1}{2}$ in.; height, 8 ft. $3\frac{1}{4}$ in.

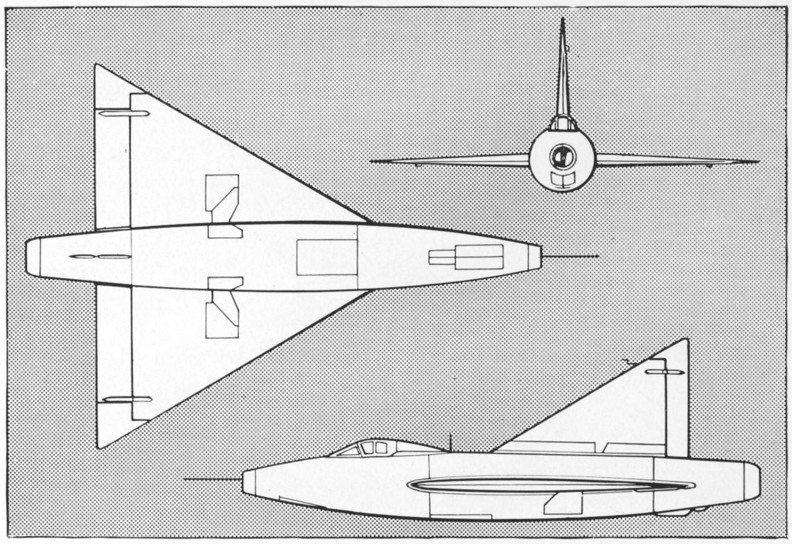


CONVAIR XF–92A (SEPTEMBER) 1948

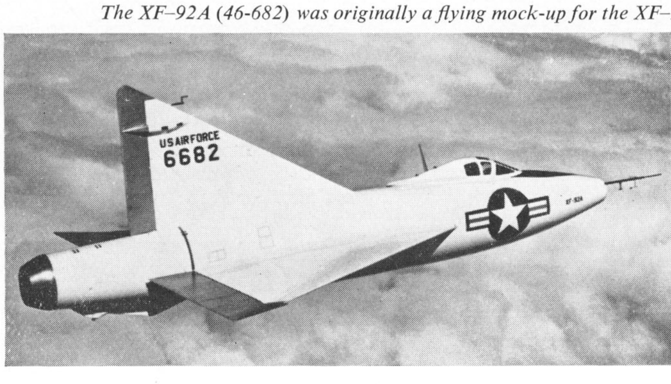
The Convair Model 7002, or XF–92A, was the world's first jet aircraft to utilise the radical delta-wing planform, flying for the first time on September 18, 1948. The XF–92A was intended as a flying mock-up for the projected turbojet-and-rocket powered XF–92 single-seat fighter designed to attain Mach 1·25 at 50,000 ft. With the cancellation of this project the XF–92A was used to provide data for the later Convair YF–102.

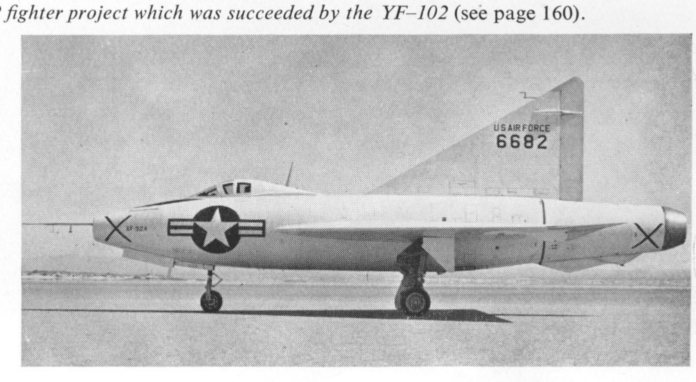
Designed in consultation with Dr. Alexander M. Lippisch, who had previously worked on delta-wing research in Germany, the XF–92A was first flown with an Allison J33–A–23 turbojet of 4,600 lb. thrust and 5,400 lb. thrust with water injection. In 1951 this unit was replaced by a J33–A–29 of similar thrust but fitted with an afterburner extension which boosted total thrust to 8,200 lb. With the latter power-plant combination, the XF–92A attained speeds up to Mach 0·95 at altitudes above 45,000 ft. during flight testing. Empty weight was 8,500 lb. and initial design loaded weight was 13,000 lb., but this was later increased to some 15,000 lb.

The XF–92A had a small, thin wing married to a large, circular-section fuselage. The wing was swept at an angle of 60° at the leading edge and had a thickness/chord ratio of only $6\frac{1}{2}$ per cent. Elevons (combining the duties of elevators and ailerons) spanned the straight trailing edge and provided lateral and longitudinal control, and the large vertical-tail surfaces provided directional stability. Overall dimensions of the XF–92A were: span, 31 ft. 3 in.; length, 42 ft. 5 in.; height, 17 ft. 8 in.



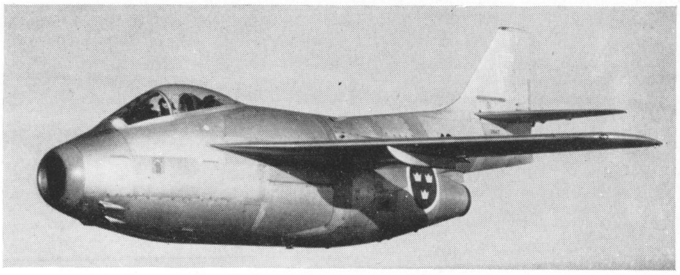
The XF–92A (46-682) was originally a flying mock-up for the XF–92 fighter project which was succeeded by the YF–102 (see page 160).



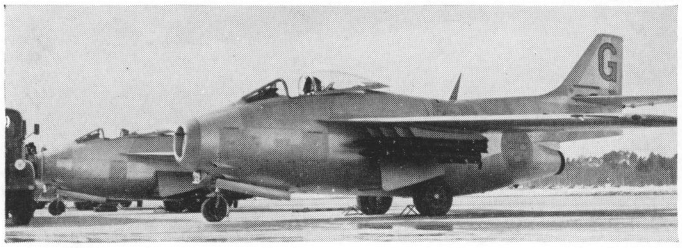


SAAB-29

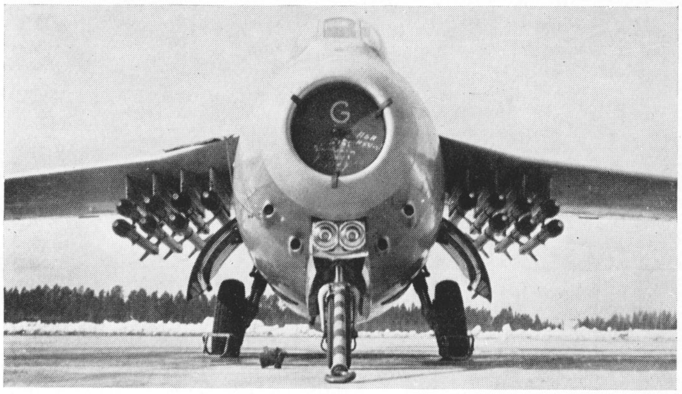
(SEPTEMBER) 1948



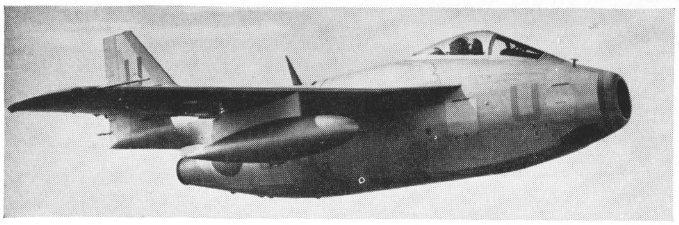
(Above) *SAAB–29A (J 29A) single-seat fighter.*



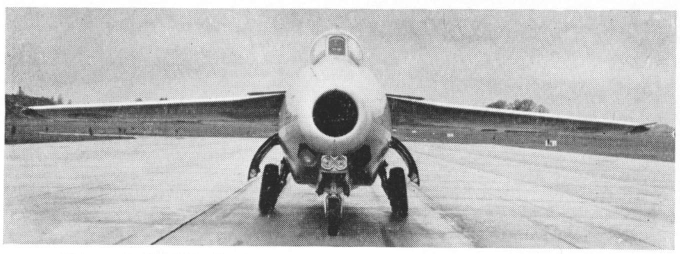
(Above) *A 29A ground attack aircraft.*



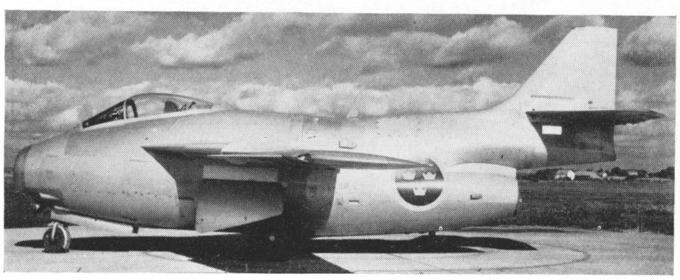
(Above) *Close-up view of Bofors rocket clusters on A 29.*



(Above) *Prototype of the S 29C photo-reconnaissance aircraft.*



(Above) *S 29C photo-reconnaissance aircraft.* (Below) *J 29F.*



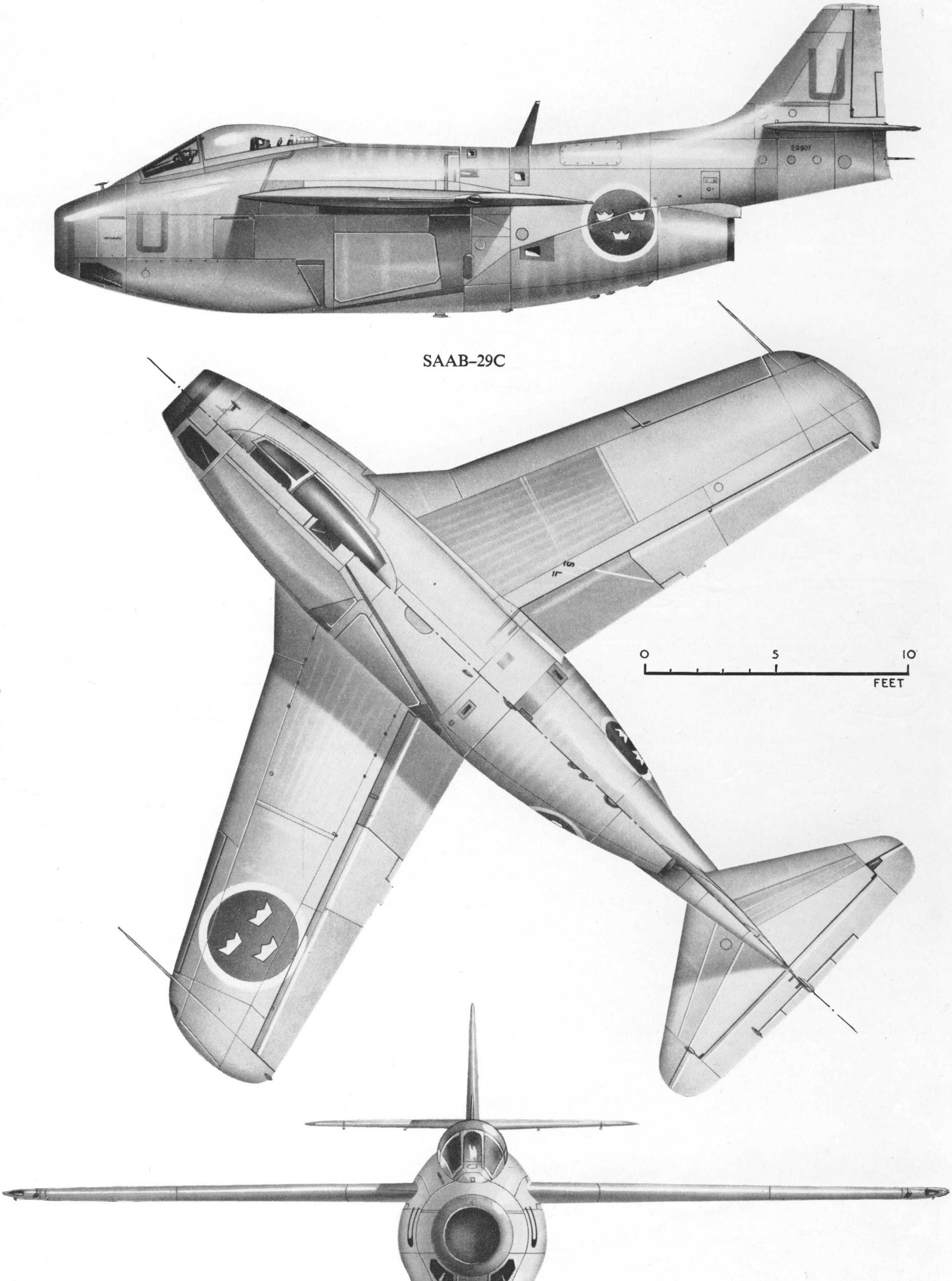
Development of the SAAB–29 single-seat fighter commenced in October 1945, the original design project being based upon the use of the 3,100 lb. thrust de Havilland Goblin turbojet. Known as the Project 1001, the fighter had a rotund fuselage housing the turbojet, main fuel tanks and undercarriage. The wing was unswept and the tail assembly was carried above the exhaust duct by a slim boom. However, by the end of the year details of the 5,000 lb. thrust de Havilland Ghost turbojet were made available and, simultaneously, the results of German wartime swept-wing research arrived in Sweden. It was therefore decided to modify the design by sweeping the wing surfaces at 25°, and to utilise the Ghost turbojet.

The first of three SAAB–29 fighter prototypes flew on September 1, 1948, powered by a 4,400 lb. thrust British-built Ghost 45, and the production prototype was flown in July 1950. The first production aircraft were delivered to the Swedish Air Force in May 1951, powered by the 5,000 lb. thrust SFA-built de Havilland Ghost 50 turbojet, becoming the first production swept-wing fighter of European design. The 25°-swept, shoulder-mounted wing is of thin laminar-flow section and is a two-spar structure with flush-riveted stressed skin. Automatic leading-edge slots are fitted and are locked in closed position when the landing-flaps are up. The gross wing area of 258 sq. ft. gives a wing loading (at normal loaded weight) of 51·6 lb./sq. ft. Initial production aircraft had dive-brakes fitted behind the wing main-spar, but these were found to cause aileron flutter on extension and were replaced by new brakes repositioned in the fuselage. The positioning and configuration of these air brakes is unusual. They are triangular wedges located immediately ahead of the main wheel bays and extend transversely across the airflow. Initial machines also had fullspan ailerons which drooped to provide flap action, but a more conventional aileron/flap system was later adopted. The ailerons now droop slightly as soon as small flaps extend beyond the high-lift limit, and are operated by an hydraulic booster system of SAAB design.

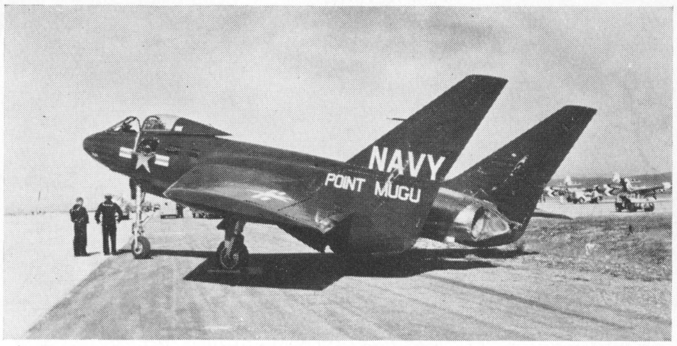
The diameter of the Ghost engine necessitated substantial fuselage bulk, and the decision to seat the pilot astride the intake ducting resulted in considerable depth. In order to provide the required rigidity and ensure adequate accessibility, a mixture of stressed-skin and frame construction is employed, the air duct forming a tubular bearer, stiffened by Z stringers, rings and bulkheads. Wings, fuselage installations and undercarriage are braced to the air duct. The fuselage comprises three sections; the forward section ahead of the cockpit is armour-plated, the centre section, containing the pilot's cockpit and turbojet, is attached to the rear section by four T spars at a point ahead of the aerial. The high-mounted tailplane is electrically adjustable in flight from $+1°$ to $-6°$. All undercarriage members and fuel tanks are contained within the fuselage which is cut back under the tail to reduce tail pipe length.

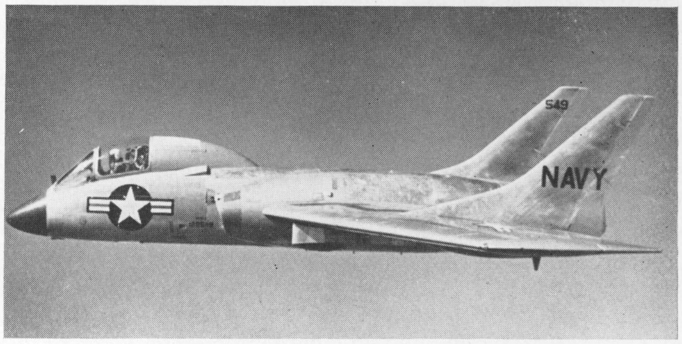
Armament comprises four 20-mm. Swedish Hispano cannon, and internal tankage can be augmented by two 88 Imp. gal. jettisonable tanks which increase maximum range to 1,677 miles. With long-range tanks fitted, limiting speed is 495 m.p.h., but in clean condition maximum speed is 658 m.p.h. at 5,000 ft. Initial climb rate is of the order of 7,500 ft./min., and service ceiling is 45,000 ft. Take-off run to clear 50 ft. obstacle is 984 yds., and landing run from 50 ft. with flaps down (at 10,120 lb.) is also 984 yds. Overall dimensions are: span, 36 ft. 1 in.; length, 33 ft. $2\frac{1}{2}$ in.; height, 12 ft. $3\frac{1}{2}$ in. Empty weight is 9,479 lb. and normal loaded weight is 13,360 lb.

The initial production fighter version was succeeded by the J 29B with increased internal tankage, and a ground attack version of the J 29A, designated A 29, was produced with underwing racks for sixteen 14·5-cm. Bofors rocket missiles or other ordnance loads. The S 29C, the prototype of which flew on June 3, 1953, is a photo-reconnaissance version with a modified nose carrying up to six cameras. The latest variant of the SAAB–29 fighter to be announced is the J 29F, which is fitted with an afterburner increasing available thrust to approximately 6,500 lb. and substantially improving climb rate. The J 29F also possesses a modified outer wing which improves the fighter's critical Mach number of 0·86. It should be noted that Mach numbers of the order of 0·9 have been attained by the J 29 fighter in dives. The J 29F entered service with Swedish fighter squadrons at the end of 1954. In May 1954 a SAAB–29 fighter established a new 500-km. closed-circuit record of 607 m.p.h.

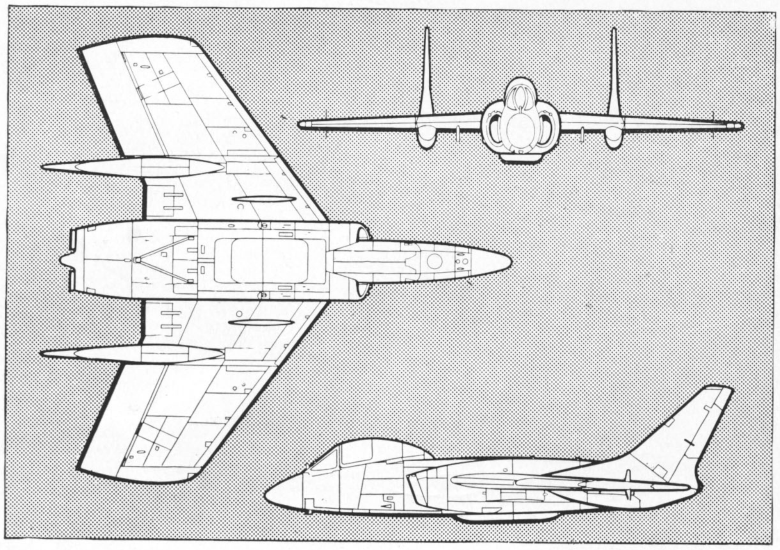


SAAB-29C





The F7U–1 Cutlass (above, left) *was generally similar to the XF7U–1, but the F7U–3* (above, right and g.a. drawing) *was extensively redesigned and strengthened.*

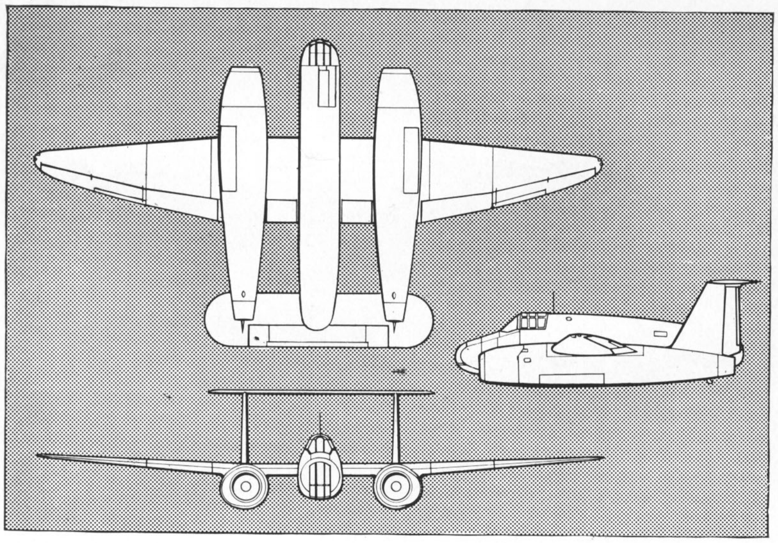


CHANCE VOUGHT F7U CUTLASS (SEPTEMBER) 1948

The Cutlass single-seat shipborne fighter was the first U.S. combat aircraft to be designed from the outset for afterburner thrust augmentation. Its unusual configuration owes much to data on tailless aircraft acquired from the German Arado company at the end of World War II, and design was initiated early in 1946, the XF7U-1 flying on September 29, 1948.

The first production model, the F7U-1, was generally similar to the prototype and, powered by two 3,000 lb. thrust Westinghouse J34-WE-32 turbojets, flew on March 1, 1950. Only nineteen F7U-1s were built, and the improved F7U-2 was superseded by the extensively redesigned F7U-3. Although designed for the Westinghouse J46 turbojet, delays with this engine necessitated the temporary installation of the Allison J35-A-21A with which the F7U-3 flew on December 20, 1951.

The J46-WE-3 turbojet, rated at 4,800 lb. thrust and 6,100 lb. with afterburning, was standardised for later production machines, and the F7U-3 attains a speed of 670 m.p.h. (and 705 m.p.h. with afterburning) at sea level. Initial climb rate of 6,000 ft./min. is increased to 12,500 ft./min. with afterburner augmentation, and combat radius is some 300 miles. Empty weight is 13,100 lb., and normal and maximum loaded weights are 20,000 lb. and 23,300 lb. respectively. Overall dimensions are: span, 38 ft. 8 in.; length, 40 ft. 10½ in.; height, 11 ft. 6½ in. Armament comprises four 20-mm. cannon and an underwing bomb load of 5,400 lb. An underbelly pod containing 2·75-in. Mighty Mouse rocket missiles can be fitted. Sub-variants include the F7U-3M missile launcher, the F7U-3P reconnaissance fighter, and the A2U-1 ground attack model.



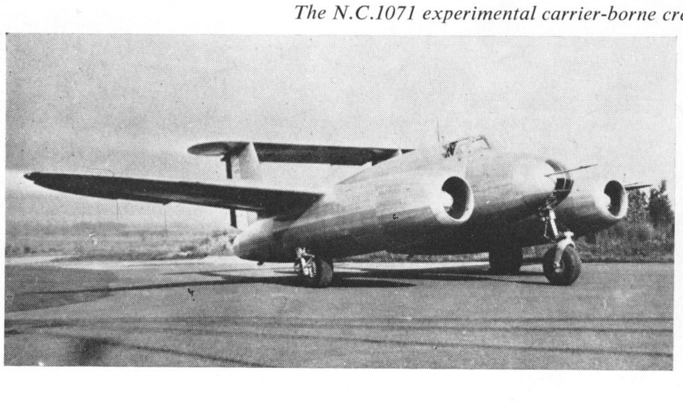
AEROCENTRE N.C.1071 (OCTOBER) 1948

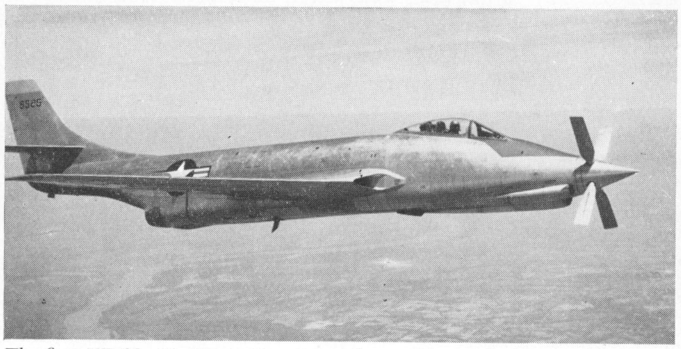
The first multi-jet aircraft of French design and construction to fly, the N.C.1071 experimental naval carrier-borne trainer was built by the Société Nationale de Constructions Aéronautiques du Centre, and flew for the first time on October 12, 1948. Of unique configuration in that the turbojet nacelles extended aft to line with the rear of the fuselage, each carrying fin and rudder assemblies which were linked at their tips by a horizontal tail surface, the N.C.1071 was powered by two 4,850 lb. thrust Hispano-built (Rolls-Royce) Nene 101 turbojets.

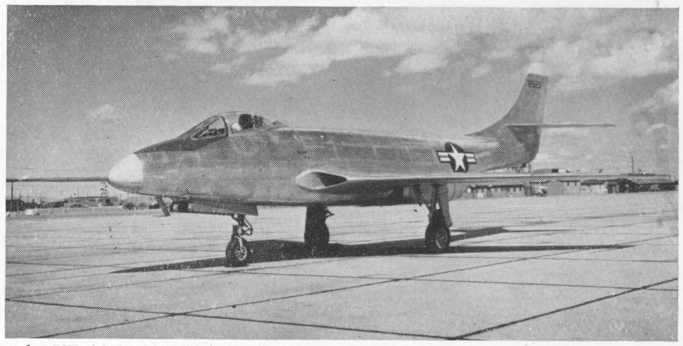
The central fuselage provided accommodation for a maximum of three crew members, and a novel form of wing folding was introduced, each half-wing breaking three times, the inner sections folding upwards and backwards, the central sections folding vertically upwards, and the outer sections folding inwards to lie one above the other. Several variants of the N.C.1071 were proposed, including an all-weather fighter (N.C.1072) and an attack bomber (N.C.1073), but after a series of flight tests further development of the design was abandoned.

The N.C.1071 had a maximum speed of 492 m.p.h. at 19,680 ft. and 450 m.p.h. at sea level. Initial climb rate was 4,725 ft./min., and service ceiling was 43,330 ft. Empty and loaded weights were 16,258 lb. and 25,190 lb. respectively, and dimensions were: span, 65 ft. 7 in.; length, 34 ft. 6 in.; height, 14 ft. 9 in.; wing area, 538 sq. ft.

The N.C.1071 experimental carrier-borne crew trainer was of unusual and inefficient design.

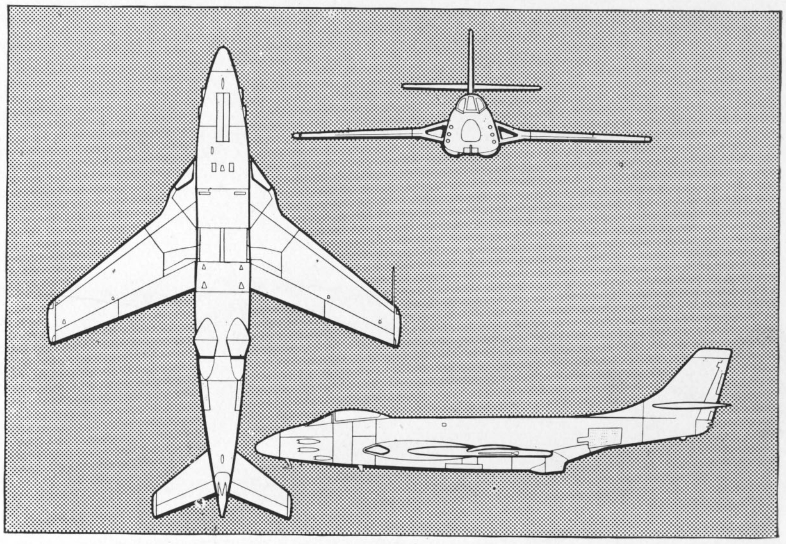






The first XF–88, 46–525, in its original form without afterburners (above, right), *the XF–88A, 46–526* (g.a. drawing), *and* (left) *the 46–525 after modification as the XF–88B.*

McDONNELL XF–88 (OCTOBER) 1948



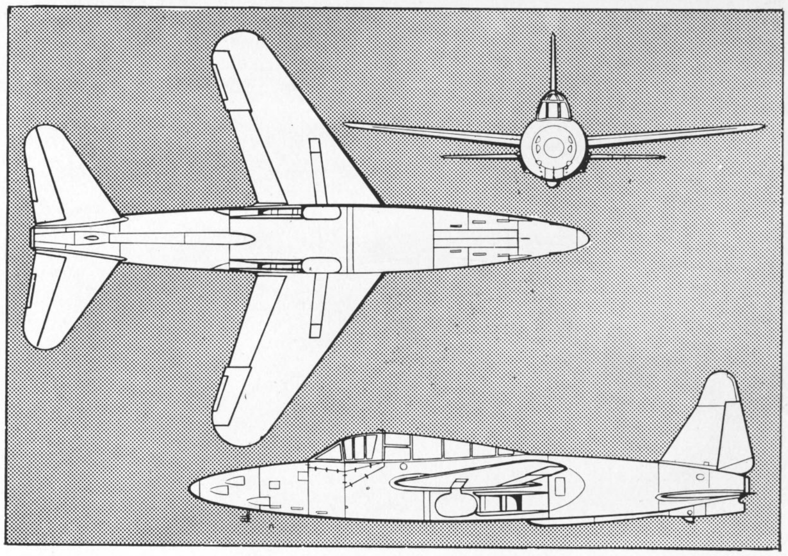
Designed to meet U.S.A.F. requirements for a heavy, long-range " penetration " fighter, the XF–88 first flew on October 20, 1948, detail design having been initiated on June 20, 1946. The XF–88 was powered by two 3,000 lb. thrust Westinghouse J34–WE–13 turbojets mounted side by side in the fuselage and exhausting just aft of the wing. A second prototype, the XF–88A, was completed in 1950 with two 3,600 lb. thrust J34–WE–22 units and short afterburners.

Changes in tactical requirements led to the cancellation of the XF–88 development contract in August 1950, but the design was revived in 1951 to meet U.S.A.F. requirements for a long-range escort fighter. With an additional fuselage bay accommodating enlarged fuel tanks and two 9,500 lb. thrust Pratt and Whitney J57–P–13 turbojets, a development of the XF–88 was placed in production as the F–101A (see page 172) and in its photo-reconnaissance form, RF–101A.

An armament of four or six 20-mm. cannon was projected for the XF–88A, and the wing was swept at an angle of 35°. The wing was exceptionally thin, the root thickness/cord ratio being 6 per cent with a reduction to 4–4½ per cent at the tip. Its area was 350 sq. ft.

The original XF–88 was modified by the installation of an XT38 turboprop in the nose to test trans-sonic and supersonic airscrews, being redesignated XF–88B. The dimensions of the Voodoo are: span, 39 ft. 8 in.; length (XF–88A) 54 ft. 1½ in.; height, 18 ft. 6 in.

SUD-OUEST ESPADON (NOVEMBER) 1948

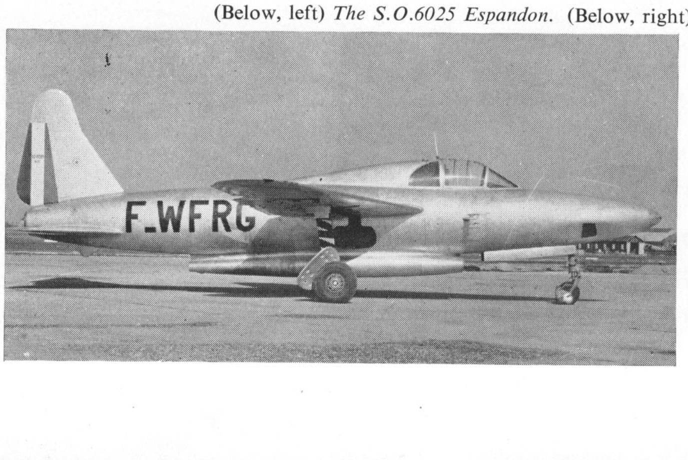


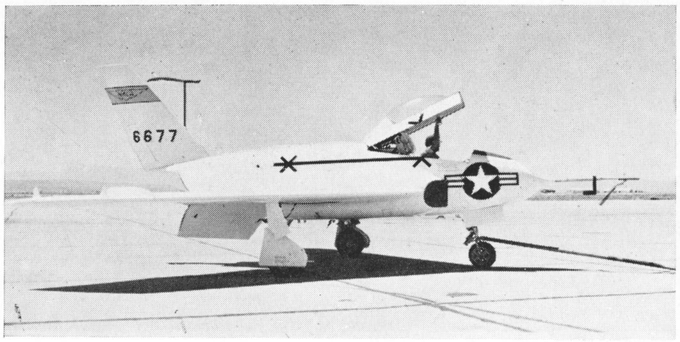
The Espadon (Swordfish) was developed under the first post-war French military aircraft programme, design being initiated in 1945. The first prototype, the S.O.6020-01 flew on November 12, 1948, powered by a 5,000 lb. thrust Rolls-Royce Nene R.N. 2 turbojet with a large ventral air intake under the wing trailing edge which occasioned appreciable duct losses. The unusually high cockpit resulted from a belated Air Ministry decision to fit an ejector seat. The S.O.6020-02, which flew on December 30, 1949, embodied extensive redesign, the ventral air intake being replaced by flush lateral intakes.

The S.O.6020-01 was modified to conform with the -02 and, in 1952, was fitted with a Turboméca Marboré turbojet at each wing-tip to provide data for the S.O.9000 Trident. The second prototype was used to flight test the 2,755 lb. thrust SEPR 251 rocket motor installed in the rear fuselage, with wing-tip tanks containing the rocket fuel. After these modifications, the -02 was redesignated S.O.6026, and flew with the rocket on October 15, 1951. The third prototype was designated S.O.6025 and flew on December 28, 1949, with a SEPR 251 rocket, fuel tanks and a ventral intake in a common under-fuselage fairing.

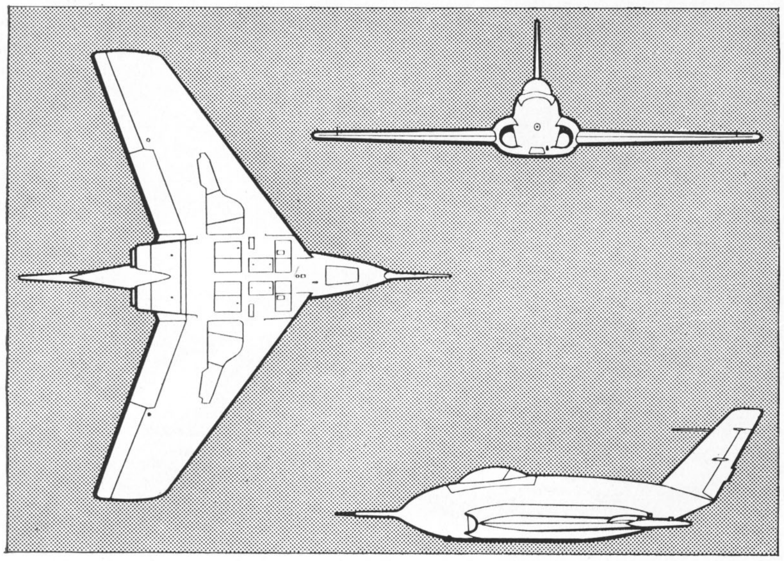
The fourth and final prototype, the S.O.6021, flew on September 3, 1950. This featured a lighter structure, increased wing area (from 270 sq. ft. to 291 sq. ft.), and servo controls. The S.O.6021 had a maximum speed of 621 m.p.h. at sea level and climbed to 33,000 ft. in 9 min. 5 sec. Service ceiling was 42,652 ft. and endurance 1 hr. 5 min. Overall dimensions were: span, 34 ft. 9 in.; length, 49 ft. 2 in.; and empty and loaded weights were 10,474 lb. and 13,422 lb. respectively.

(Below, left) *The S.O.6025 Espandon.* (Below, right) *The S.O.6020–01 and* (g.a. drawing) *the S.O. 6021.*





Two X–4 Bantam research aircraft were built to study the characteristics of tailless aircraft.

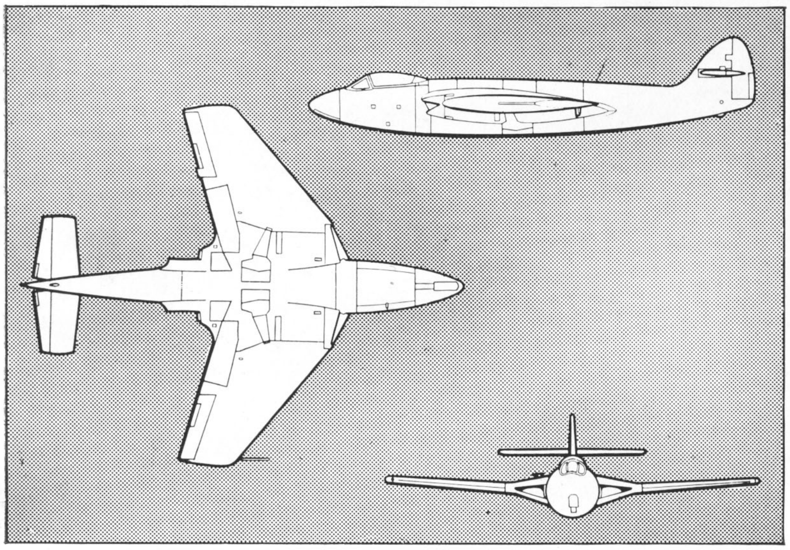


NORTHROP X–4 (DECEMBER) 1948

Built to explore stability and flight characteristics of swept-wing tailless aircraft at high subsonic speeds, the X-4 Bantam was similar in basic aerodynamic concept to the earlier de Havilland D.H.108 research aircraft. Departing from previous Northrop jet flying-wing practice wherein a relatively thick section wing merged with a deeper centre section housing the crew, the X-4 reflected German techniques.

The first of two X-4 Bantam research aircraft flew in December 1948, powered by two 1,600 lb. thrust Westinghouse J30-WE-1 turbojets located in bulged wing-root housings and exhausting under the upswept rear fuselage cone. The mid-positioned wing was of thin section and swept 40° on the leading edge. Elevons were carried on the trailing edge of the wing, and the vertical tail surfaces were of high-aspect ratio with pronounced sweepback. Despite the diminutive proportions of its cockpit, the X-4 carried an ejector seat for the pilot and very comprehensive N.A.C.A. test instrumentation. The cockpit hood folded backwards and, in an emergency, could be released, the air stream forcing it backwards to allow clearance for the ejector seat.

The design gross weight of the X-4 was 7,000 lb., and its overall dimensions were exceptionally small: span, 26 ft. 10 in.; length, 23 ft. 4 in.; height, 14 ft. 10 in. The X-4 was not intended to exceed Mach unity but for high trans-sonic speeds, and Mach numbers of the order of 0·95 could be attained in a shallow dive. Maximum level speed was approximately 630 m.p.h. at 10,000 ft. The X-4 Bantam completed an extensive research programme with the N.A.C.A.



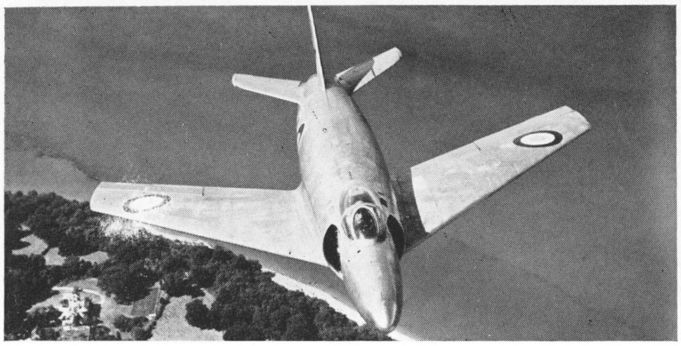
HAWKER P.1052 (DECEMBER) 1948

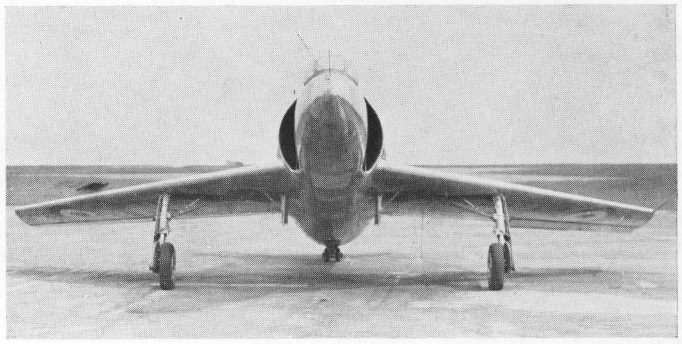
Built primarily as a research aircraft to investigate the behaviour of sweptback wings at low speeds from the points of view of controllability and stability, the P.1052 made use of similar fuselage, empennage, landing gear and turbojet to those of the first Hawker jet fighter, the P.1040. Intended to meet specification E.38/46, the first of two P.1052 research aircraft flew on December 19, 1948, powered by a 5,000 lb. thrust Rolls-Royce Nene R.N. 2 turbojet.

The P.1052 differed from the earlier P.1040 primarily in having a 35° swept wing which provided a higher usable Mach number. Possessing a broader root chord than that of the P.1040, the wing employed deeper spars to alleviate the increased bending and torsional loads arising from the sweepback. Some strengthening of the frames in the fuselage to which the spars were attached was necessary and the front attachment points were moved forward. The span of the tailplane was reduced by the deletion of the rounded tips of the P.1040 and their substitution by blunt tips. These were replaced by an all-swept empennage for a further series of trials. The overall dimensions of the P.1052 were: span, 31 ft. 6 in.; length, 37 ft. 9½ in.; height, 10 ft. 1 in.; wing area, 258 sq. ft.

The first prototype P.1052 was used to gain experience with the operation of swept-wing aircraft from the decks of carriers, arrester-gear and other specialised equipment being fitted in 1951. The second prototype P.1052 was fitted with a new rear fuselage in 1950 and redesignated P.1081. The P.1052 was capable of attaining speeds of the order of 650 m.p.h. in level flight.

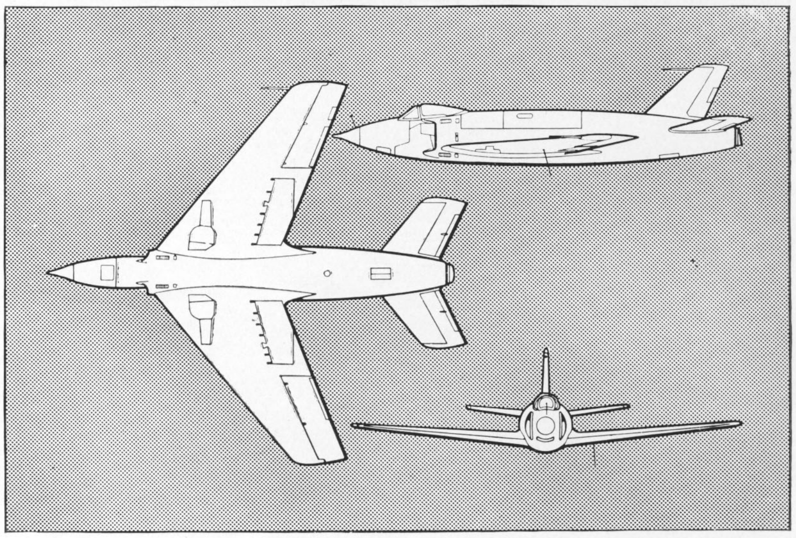
(Below, left) *The second P.1052 (VX279) later converted as the P.1081.* (Below, right) *The first P.1052 (VX272), now flying with swept tail.*





The Supermarine Type 510 research aircraft (VV106), predecessor of the Swift single-seat fighter.

SUPERMARINE TYPE 510 (DECEMBER) 1948



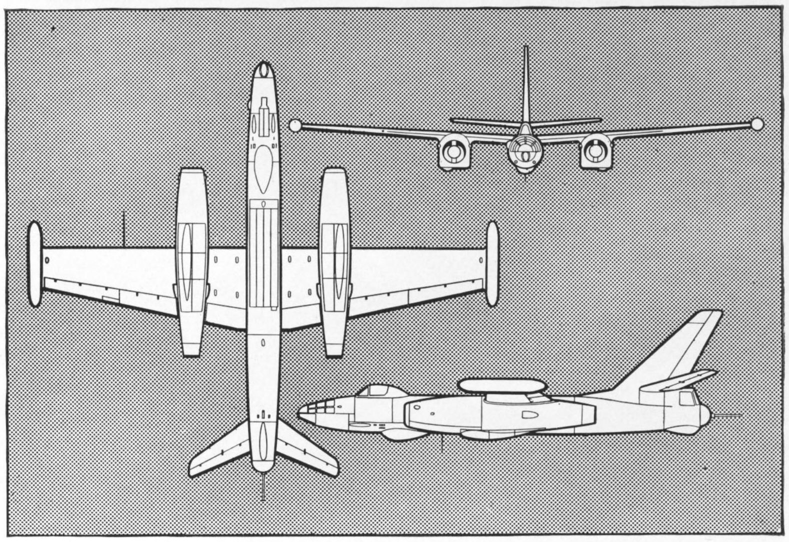
The Supermarine Type 510 was virtually a Supermarine Attacker fuselage married to swept wing and tail surfaces, and produced to meet specification E.41/46 for an aircraft suitable for investigating flight phenomena at high subsonic speeds. Retaining the tailwheel undercarriage and 5,000 lb. thrust Rolls-Royce Nene turbojet of the Attacker, the Type 510 was flown for the first time on December 29, 1948, and on November 8, 1950, gained the distinction of becoming the first swept-wing aircraft to land on a carrier deck. For its successful series of deck-landing trials aboard H.M.S. *Illustrious* the Type 510 was equipped with deck arrester gear and RATOG.

The wing of the Type 510 was of laminar-flow section and was swept at an angle of 40° at quarter-chord. Span and gross area were 31 ft. 8½ in. and 273 sq. ft. respectively. The fuselage length was 38 ft. 1 in., and, tail down, the overall height was 8 ft. 9¾ in.

A second machine, designated Type 517 and featuring an extended rear fuselage housing afterburning equipment, made several flights before receiving further modifications in the form of a lengthened fuselage nose which appreciably improved fineness ratio, and a nosewheel undercarriage. In this form, the Type 517 became the Type 535, predecessor of the Type 541 prototype Swift.

The Type 510 carried extensive research instrumentation and attained level speeds of 650 m.p.h. during flight testing. No other details of the performance attained by the Type 510 have been revealed, but this aircraft played a major role in the development of the Swift single-seat fighter.

ILYUSHIN IL–28 (BUTCHER) (LATE) 1948

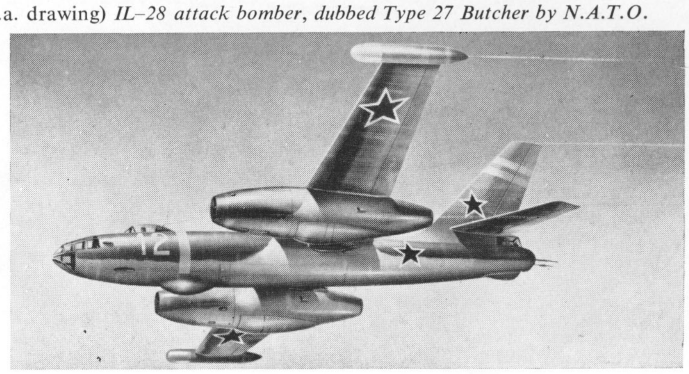


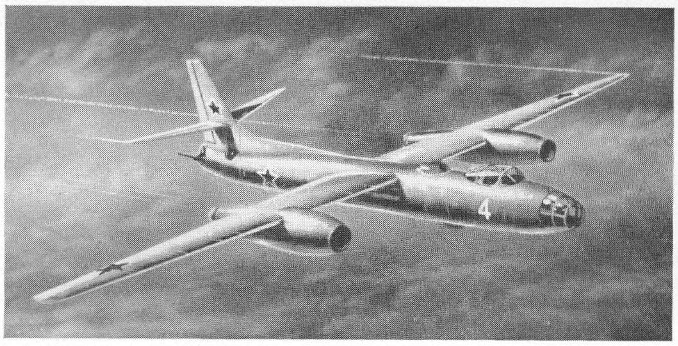
The first jet bomber of Soviet design to be produced in quantity and known to have been designed by a team headed by Sergei Ilyushin, the IL-28 three-seat light tactical bomber entered service with the Soviet Air Force during 1949-50, and has since been produced in considerable quantities for the air arms of Russia and her allies. There is some doubt as to the type of turbojet employed by the IL-28, the prototype of which is believed to have flown late in 1948, but it is likely that two axial-flown units derived from the Jumo 004H and developing 5,000-6,000 lb. thrust each are installed in most production models.

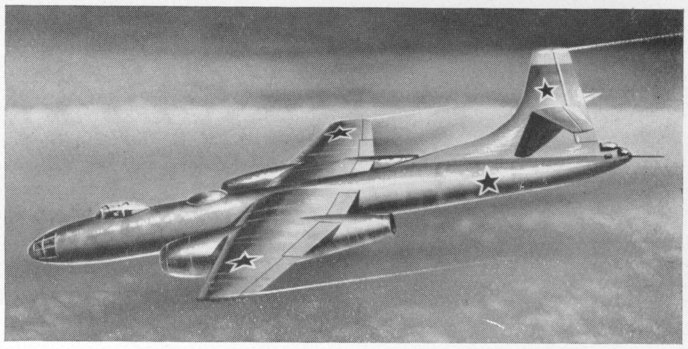
The most noteworthy feature of the IL-28 is the positioning of the wing on the fuselage. This is mounted unusually far aft, and reasonable c.g. travel is attained by the forward-mounting of the two lengthy, square-section turbojet nacelles which are underslung on the wing. The wing has a span of some 68 ft. and has no taper on the leading edge. Both vertical and horizontal tail surfaces are swept. Length and height are approximately 62 ft. and 22 ft. respectively. A conversion trainer variant with a second cockpit ahead of the normal pilot's cockpit is also in service. Another version is reportedly a heavy intruder fighter with a fixed nose armament, but there is as yet little concrete evidence to support the rumoured existence of a swept-wing variant of the IL-28.

No details are available concerning the performance of the IL-28, but it is reasonable to assume that, with a total thrust of some 11,000 lb., maximum speed is unlikely to exceed 580 m.p.h., and range is probably of the order of 2,000 miles.

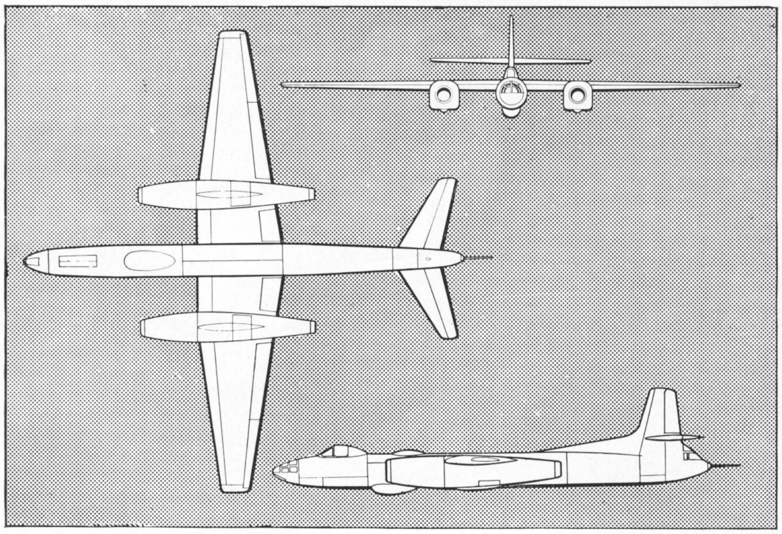
(Below, left) *Artist's impression of U–IL–28 trainer.* (Below, right and g.a. drawing) *IL–28 attack bomber, dubbed Type 27 Butcher by N.A.T.O.*







(Above and g.a. drawing) *The Tupolev-designed attack bomber used by Soviet Navy shore-based units, and known as the Type 35 Bosun by N.A.T.O. forces.*

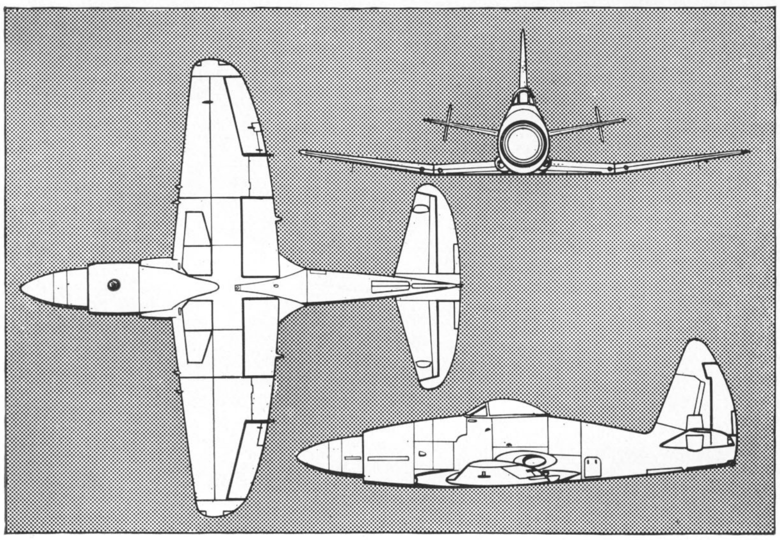


TUPOLEV (TYPE 35 BOSUN) (EARLY) 1950

Representative of the first generation of Soviet jet bombers, the Type 35—which appellation has been bestowed upon this aircraft type by the N.A.T.O. air forces for identification purposes—is believed to be the first jet combat aircraft design supervised by Andrei N. Tupolev to have been produced in quantity. Operated by the shore-based elements of the Soviet naval air arm, the Type 35 is primarily an attack and anti-shipping bomber and is presumed to have flown in prototype form during the early part of 1950. It is known to have been in service during the closing months of the following year.

Of orthodox design, the Type 35 has a shapely circular-section fuselage, the lines of which are marred by large, clumsily-designed vertical tail surfaces. The equi-tapered, shoulder-mounted wing spans approximately 70 ft. and carries two lengthy, square-section turbojet nacelles underslung and projecting well forward of the leading edge. The power plants housed within these nacelles are not known with certainty; and although some reports have suggested the installation of centrifugal type units, it is generally believed that they are axial-flow units derived from the German Junkers Jumo 004H and each possessing a thrust in the 5,000–6,000 lb. range.

It is to be presumed that sweepback was adopted for the tail-plane in order to increase the critical Mach number of this component at the upper limit of the Type 35's performance range. While no details of performance are available, it is generally assumed that maximum speed is within the 550–600 m.p.h. range and that radius of action exceeds 600 miles.



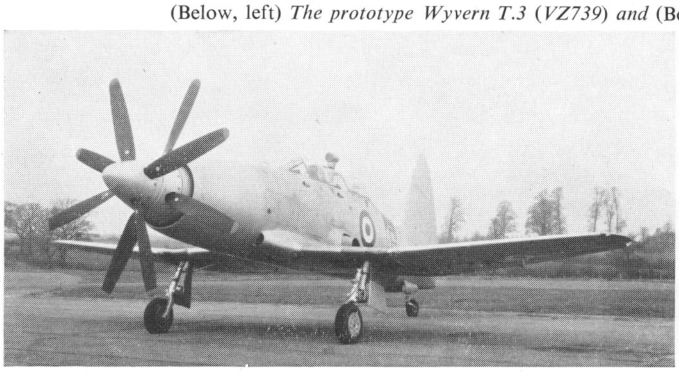
WESTLAND WYVERN (JANUARY) 1949

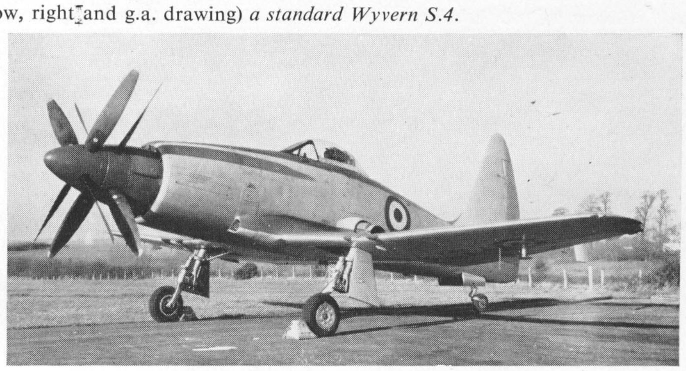
The Westland W.35 Wyvern was derived from the piston-engined W.34 Wyvern T.F.1, and four prototypes were ordered, one powered by the 4,030 e.h.p. Rolls-Royce Clyde R.C.3 and three powered by the 4,110 e.h.p. Armstrong Siddeley Python A.S.P.1. The Clyde-powered prototype flew on January 18, 1949, and was followed two months later, on March 22, by the first Python-powered prototype. The discontinuation of the Clyde turboprop resulted in the Python being chosen as the standard engine for the production model.

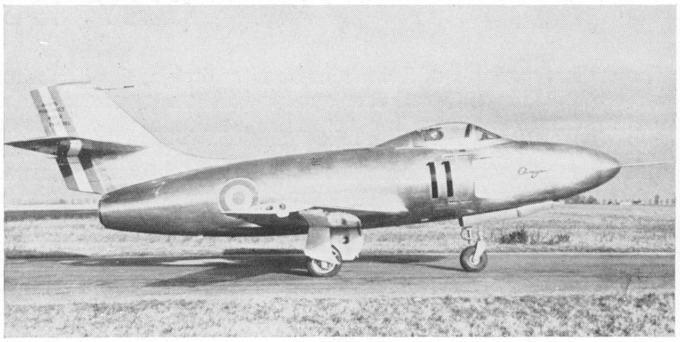
The first production model, the Wyvern T.F.2, was powered by the Python A.S.P.1, and the prototype of a two-seat armament trainer variant, the W.38 Wyvern T.3, was built and flown for the first time on January 11, 1950. The major production model, the Wyvern S.4, differed from the T.F.2 in having the later Python A.S.P.3 turboprop of 3,670 s.h.p. plus 1,180 lb. thrust (4,110 e.h.p), with a "cut back" engine cowling to facilitate the loading of starter cartridges, a stiffened cockpit canopy, modified aileron tabs and auxiliary tail fins.

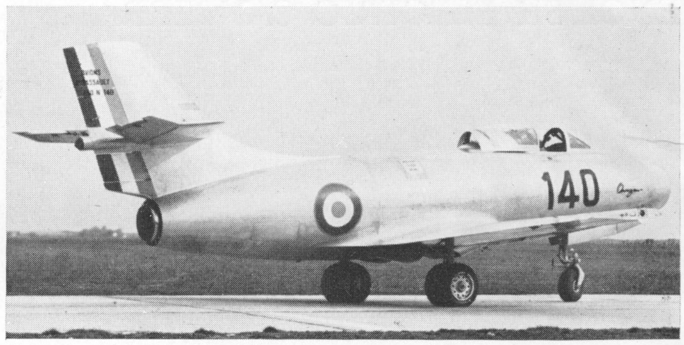
The Wyvern S.4 was the first combat aircraft powered solely by an airscrew turbine power plant to enter service. Intended for the carrier-borne strike role, the Wyvern has a built-in armament of four 20-mm. cannon and can carry a torpedo beneath the fuselage and sixteen rocket projectiles or alternative ordnance loads beneath the wing. Approximate empty and loaded weights are 15,290 lb. and 24,300 lb. respectively. Maximum speed is of the order of 550 m.p.h., and overall dimensions are: span, 44 ft.; length, 42 ft. 3 in.; height, 15 ft. 9 in.; wing area, 355 sq. ft.

(Below, left) *The prototype Wyvern T.3 (VZ739) and* (Below, right) and g.a. drawing) *a standard Wyvern S.4.*



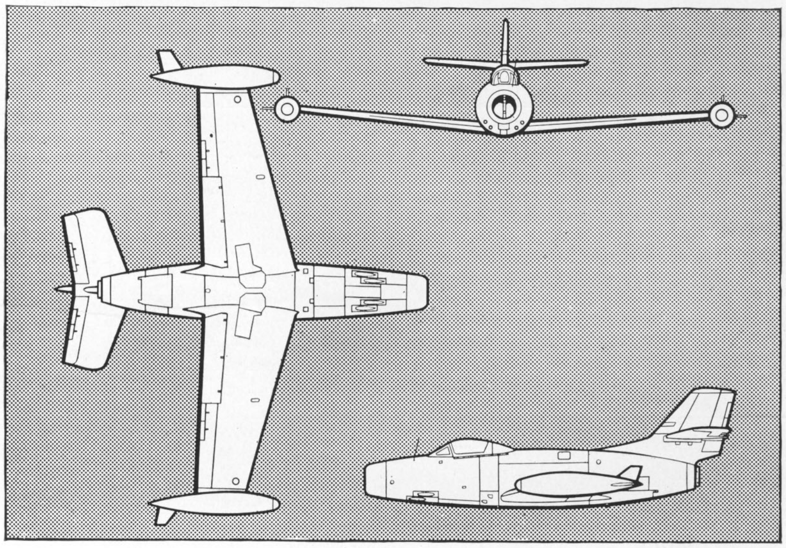






(Above, left) *The experimental MD—450–30L with lateral intakes.* (Above, right) *MD–450–140 with experimental undercarriage.*

DASSAULT OURAGAN (FEBRUARY) 1949

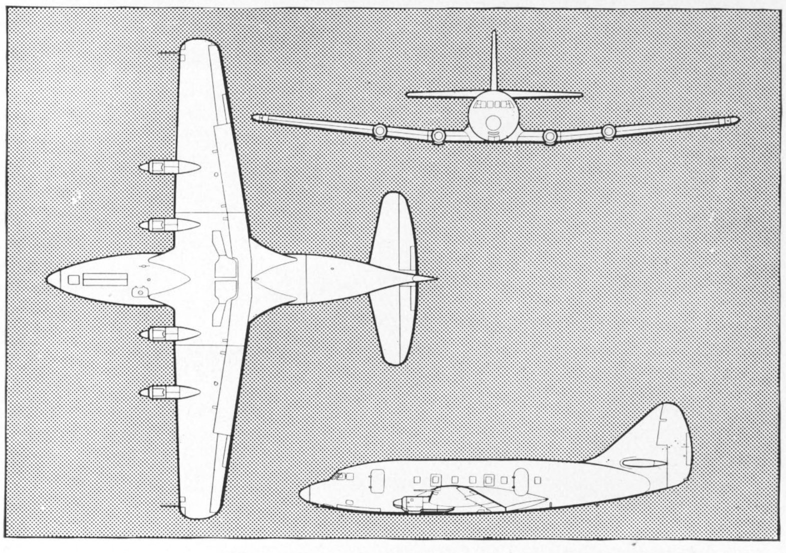


The first jet fighter of French design to be produced in quantity, the Ouragan flew for the first time on February 28, 1949, with a 5,000 lb. thrust Hispano-Suiza Nene 102 turbojet. The similarly-powered second prototype, the MD-450-02, flew on July 22, 1949, and a third prototype, the MD-450-03, powered by a 5,070 lb. thrust Nene 104B, flew on June 2, 1950.

The prototypes were followed by twelve pre-production aircraft and 350 production machines, ninety-one of the latter being supplied to the Indian Air Force (5,180 lb. thrust Nene 105A) by which it is known as the *Toofani.* Several pre-production and production Ouragans have been used for research; MD-450-3 was fitted with an afterburning Nene 102B which gave a total thrust of 6,800 lb.; MD-450-8 and MD-450-12 were used for armament experiments, the latter having two 30-mm. DEFA cannon; MD-450-11 (designated MD-450-30L) also carried 30-mm. guns and tested the lateral intakes projected for the two-seat MD-451 Aladin and MD-453 fighters; the MD-450-11 and MD-450-12 were later used as test-beds for the SNECMA Atar 101B of 5,510 lb. thrust, and MD-450-140 was fitted with twin-wheel main undercarriage members.

The production Ouragan was powered by a 5,070 lb. thrust Nene 104B, with which maximum speed was 584 m.p.h. at sea level, initial climb rate 7,874 ft./min., and ceiling 49,213 ft. Empty and loaded weights were 9,131 lb. and 14,991 lb. and fixed armament comprised four 20-mm. Hispano 404 Model 50 cannon. An underwing load of two 1,100-lb. bombs could be carried. Overall dimensions were: span, 40 ft. 3½ in.; length, 35 ft. 2¼ in.; height, 13 ft.; wing area, 256·18 sq. ft.

ARMSTRONG WHITWORTH A.W.55 APOLLO (APRIL) 1949



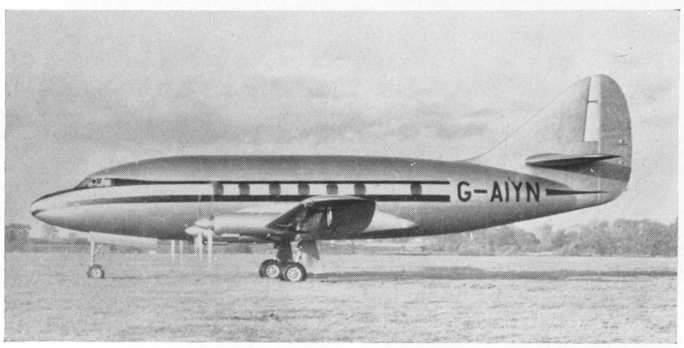
Designed as a 26–31 passenger medium-stage airliner meeting the recommendations of the Brabazon Committee's Type IIB classification, the A.W.55 Apollo was the second turboprop-powered commercial aircraft to fly. With four 1,135 e.h.p. Armstrong Siddeley Mamba A.S.Ma.1 turboprops and orthodox in general conception, the first Apollo flew on April 10, 1949.

Initial flight testing resulted in a number of modifications. Four-blade airscrews replaced the three-bladers on the inboard Mambas to rectify some skin buffeting in the plane of the airscrews, a dorsal fin was added to eliminate a tendency towards rudder stall and locking under asymmetric power, tailplane span was increased to overcome longitudinal instability in the climb, and the flap arrangement was modified.

The Apollo received its Certificate of Airworthiness in 1950, and a second prototype, incorporating the modifications applied to the first prototype and powered by four 1,475 e.h.p. Mamba A.S.Ma.3 turboprops, flew for the first time on December 12, 1952. No production of the Apollo was undertaken, and the two prototypes have been used for development and research by the Ministry of Supply.

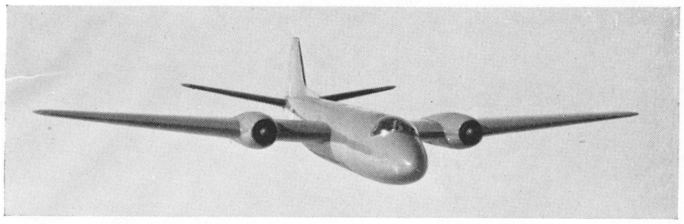
The second prototype Apollo had a maximum continuous cruising speed of 310 m.p.h. at 25,000 ft., and, with a total fuel capacity of 972 Imp. gal., had a range of 1,130 miles cruising at 280 m.p.h. at 25,000 ft. with a 7,500 lb. payload. Maximum still air range was 1,350 miles, and initial climb rate 1,480 ft./min. Normal loaded weight was 47,000 lb., and dimensions were as follows: span, 92 ft.; length, 71 ft. 5½ in.; height, 26 ft.; gross wing area, 986 sq. ft.

(Below, left) *The second prototype Apollo* (*VX224*), *originally G–AMCH.* (Below, right) *First prototype G–AIYN, later VX220.*

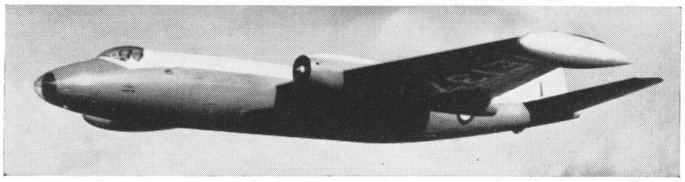


ENGLISH ELECTRIC CANBERRA

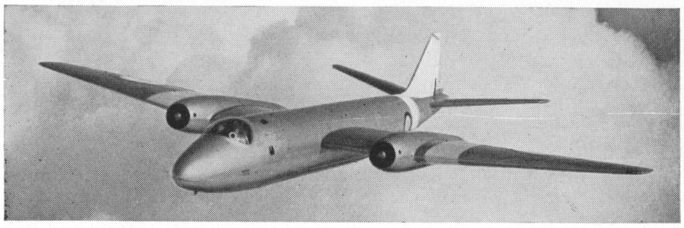
(MAY) 1949



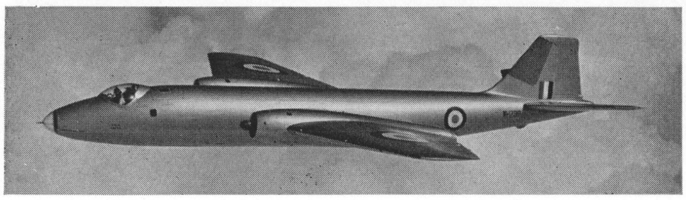
(Above) *The first Canberra B.1 prototype* (*VN799*).



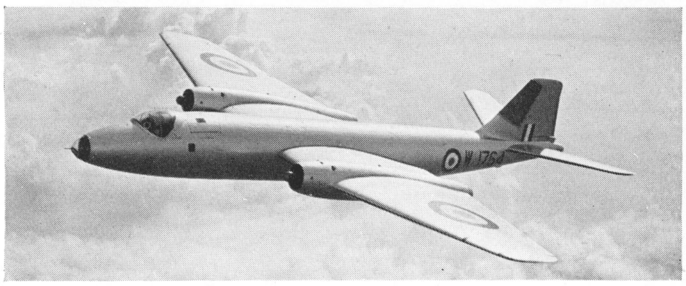
(Above) *Canberra P.R.3* (*WE137*).



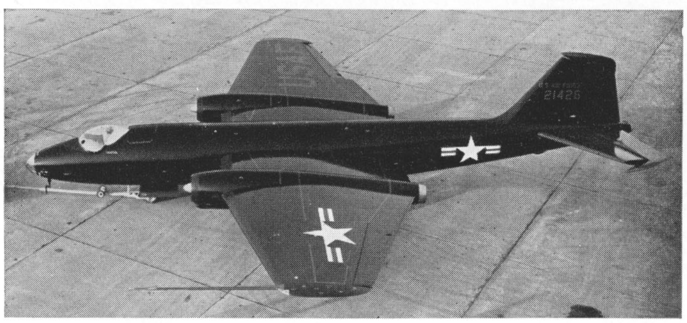
(Above) *Canberra T.4* (*WN467*).



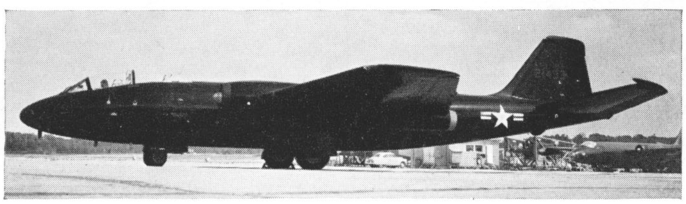
(Above) *Canberra P.R.7* (*WH799*).



(Above) *Canberra B.6* (*WJ764*).



(Above) *Martin RB–57A* (*52–1426*) *and* (below) *B–57B* (*52–1493*).



The earliest example of British jet-bomber design, the Canberra was conceived in 1945 and developed to fulfil the requirements of specification B.3/45, calling for a high-altitude light bomber with long-range characteristics and sufficient speed and manœuvrability to eliminate the need for defensive armament.

Contrary to general trends towards thinner and more highly loaded wings, a low-aspect ratio (4·3) wing with modest thickness/chord ratio (12 per cent at the root decreasing to 9 per cent at the tip) and comparatively low loading (approximately 40–42 lb./sq. ft.) was chosen. This wing form was dictated primarily by the desire to achieve the highest possible cruising altitude for maximum fuel economy and to render interception difficult. It also endowed the Canberra with the virtues of exceptional manœuvrability, particularly at extreme altitudes, and outstanding low-speed-handling characteristics.

The Canberra was designed initially as a two-seater with radar bombing aids, and the first four prototypes, designated Canberra B.1, were completed as two-seaters. The first prototype Canberra flew on May 13, 1949, powered by two 6,000 lb. thrust Rolls-Royce Avon R.A.2 turbojets, and was followed on November 9, 1949, by the second prototype. The latter was powered by two 5,000 lb. thrust Rolls-Royce Nenes which were envisaged as possible alternative power plants in case of production delays with the Avon. The third, fourth and subsequent prototypes were Avon-powered, and the fifth prototype embodied a revised fuselage nose for visual bomb-aiming and carried a third crew member. This version was placed in quantity production as the Canberra B.2, and, powered by two 6,500 lb. thrust Avon R.A.3 engines, the first deliveries were made to the R.A.F. in January 1951.

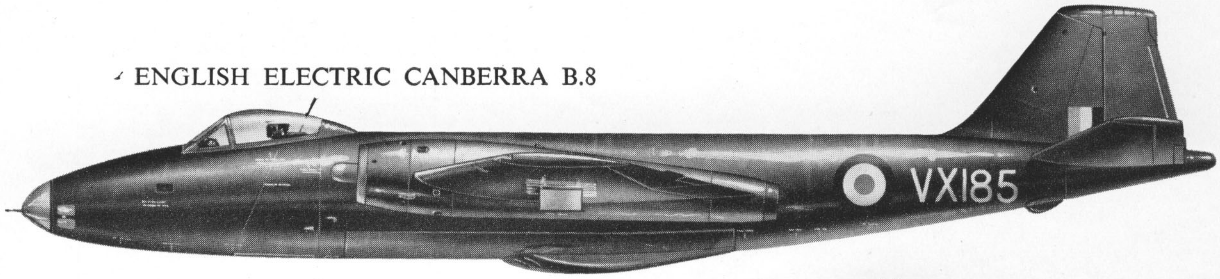
The Canberra P.R.3 was generally similar to the B.2 but carried equipment for high-altitude photographic reconnaissance. Fuselage length was increased from 65 ft. 6 in. to 66 ft. 8 in. to accommodate additional internal fuel tanks, and the offset bomb aiming panel in the transparent nose cap was deleted. The Canberra T.4 was a dual-control trainer variant of the B.2, with pupil and instructor seated side by side and a navigator aft. The experimental Canberra B.5 "target marker" version of the B.2 had a large-area optically-flat panel beneath the nose.

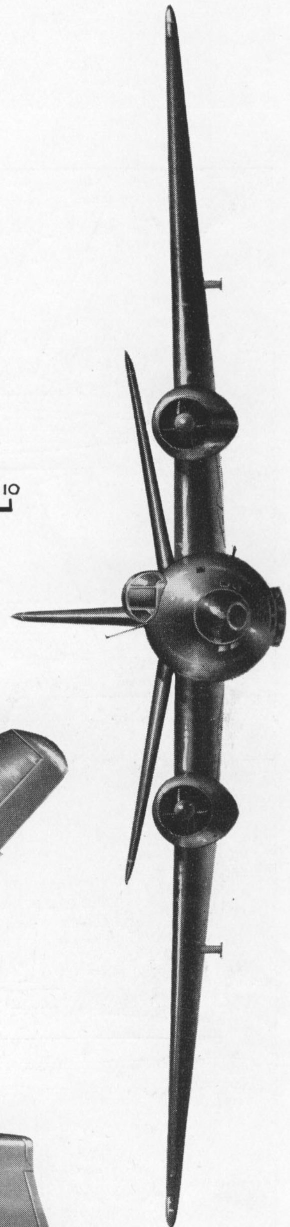
The B.2 light bomber was succeeded by the Canberra B.6, which had the lengthened fuselage and increased internal fuel tankage of the P.R.3 and 7,500 lb. thrust Avon R.A.7 engines. The Canberra P.R.7 was a high-altitude photographic-reconnaissance variant of the B.6.

The Canberra B.8, the prototype of which (originally the sole Canberra B.5) flew on July 23, 1954, is distinguished from previous variants in having a completely redesigned nose with a very large fighter-type canopy offset to port for the pilot and a second crew member forward. The rear section of the bomb-bay can house a gun pack containing either four 20-mm. or 30 mm. cannon. This pack is quickly detachable for rearming or replacement by different weapons. Although intended primarily for long-range night interdiction, the Canberra B.8 is readily adaptable for the high-altitude bombing role. Like the B.6 and P.R.7, the B.8 has two 7,500 lb. thrust Avon R.A.7 engines, and overall dimensions are: span, 63 ft. $11\frac{1}{2}$; length, 65 ft. 6 in. in.; height, 15 ft. 7 in.; wing area 960 sq. ft. Maximum speed is approximately 630 m.p.h., service ceiling 50,000 ft. and maximum range, 3,000 mls.

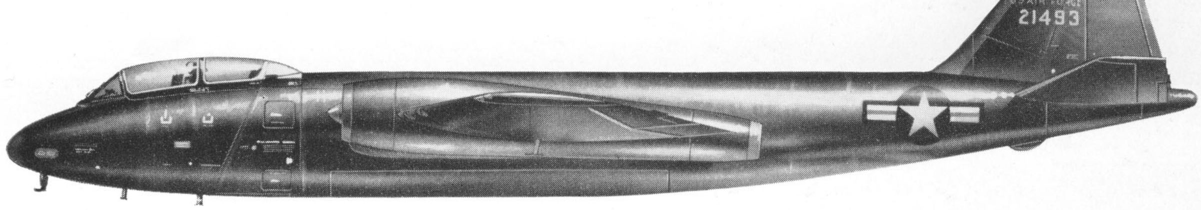
Forty-eight Canberras are currently being built in Australia under the designation B.20. Initial production aircraft have 6,500 lb. thrust Avon engines, but later aircraft have 7,500 lb. thrust Avon 109 (R.A.7) turbojets. The Canberra is also built in the U.S.A. in extensively modified form as the Martin (Model 272) RB–57A and B–57B, the former being a reconnaisance-bomber externally similar to the Canberra B.2, and the latter being a night intruder with tandem seating for the crew members. Both RB–57A and B–57B are two-seaters powered by the 7,200 lb. thrust Wright J65–W–3 or W–5, and the B–57B carries a forward-firing armament of eight 0·5-in. guns in the wing leading-edge, and eight 5-in. HVAR missiles or other underwing ordnance loads. A rotary bomb-bay is installed which is claimed to eliminate the turbulence resulting from the opening of orthodox bomb-bay doors at high speeds. The B–57B weighs approximately 4,000 lb. more than the Canberra B.6, approximate empty and loaded weights being 30,000 lb. and 49,000 lb. respectively. A dual-control trainer variant of the B–57B is also in production for the U.S.A.F. as the B–57C.

ENGLISH ELECTRIC CANBERRA B.8

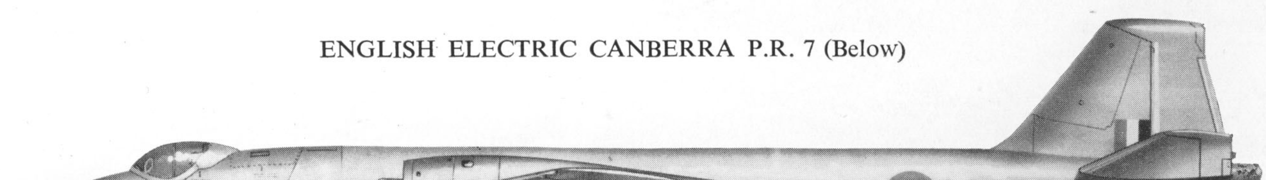


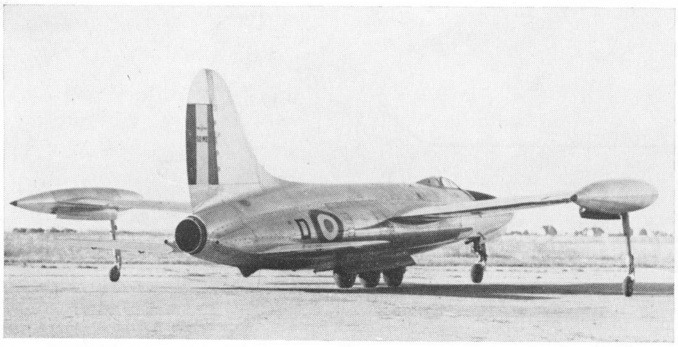


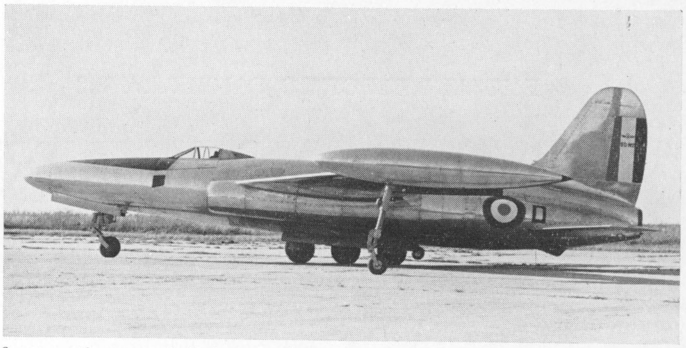
MARTIN B-57B (Below)



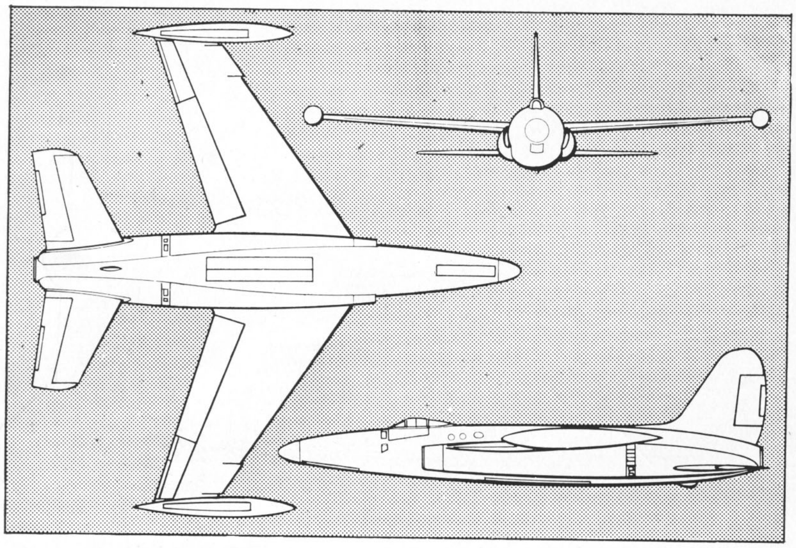
ENGLISH ELECTRIC CANBERRA P.R. 7 (Below)







The experimental S.O. M.2 after modifications for second flight-test phase.

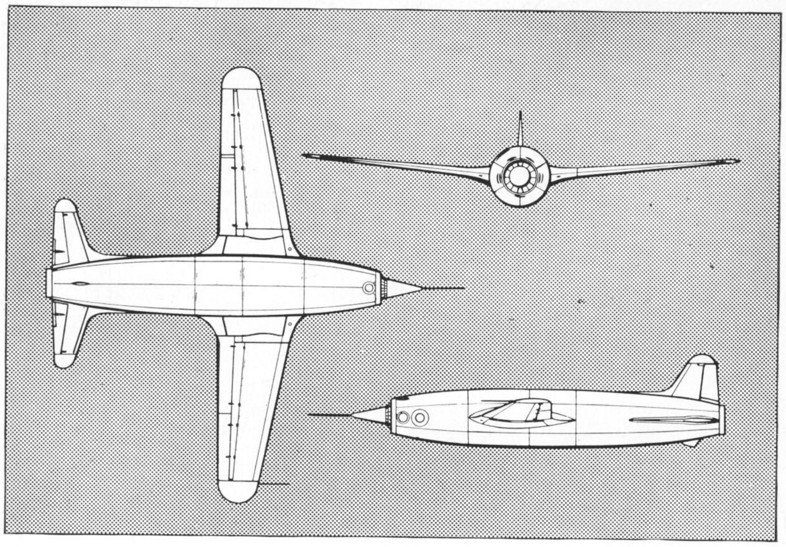


SUD-OUEST S.O. M.2 (APRIL) 1949

Built as a piloted half-scale model of the S.O.4000 two-seat light bomber, the S.O. M.2 single-seat research aircraft flew for the first time on April 13, 1949, and in May 1950 became the first French aircraft to exceed 1,000 km./h. (621 m.p.h.) in level flight.

The M.2 had a laminar-flow wing swept at an angle of 31° at the main spar. Fowler-type flaps occupied the entire wing trailing edge, and the small ailerons at the tips were inter-connected with spoilers to provide lateral control. Slots were fitted on the leading-edge, and span and wing area were 31 ft. 2 in. and 193·7 sq. ft. The lateral air intakes for the 3,500 lb. thrust Rolls-Royce Derwent 5 turbojet stood proud from the fuselage and were positioned ahead of the wing leading-edge, the intake ducts being housed in long fuselage fairings. The fuselage length was 32 ft. 5½ in. The landing gear was unusual in that it embodied three tandem mainwheels, a nosewheel and small stabilising wheels retracting into the wingtips.

For the second flight-test phase, which commenced on September 15, 1951, after the unsuccessful testing of the S.O.4000 bomber, hydraulic servo controls were fitted, auxiliary fuel tanks were mounted at the wing-tips, the undercarriage retraction mechanism was revised and provision was made for the installation of powder rockets to augment thrust during high-altitude trials. Empty weight was increased from 8,467 lb. to 9,350 lb., and loaded weight from 10,363 lb. to 11,900 lb. A 264 lb. load of test instrumentation was carried and considerable data on the effects of various control systems at high altitudes and in the Mach 0·9–0·93 range was obtained.



LEDUC 010 (016) (APRIL) 1949

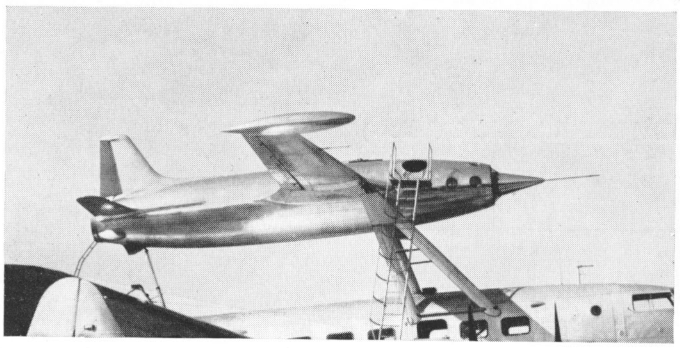
The Leduc 010 was the first manned aircraft to be powered solely by a ramjet or athodyd. Originally designed in 1937 by M. Rene Leduc, the first machine, the Leduc 010–01, was not completed until 1945. Its fuselage comprised inner and outer shells, the inner shell housing the pilot's cockpit, which was surrounded by an annular duct forming the ramjet. Injector pumps and generator driven by an auxiliary gas turbine were installed aft of the cockpit, and behind this central body were a series of rings around which were arranged the fuel injectors and burners.

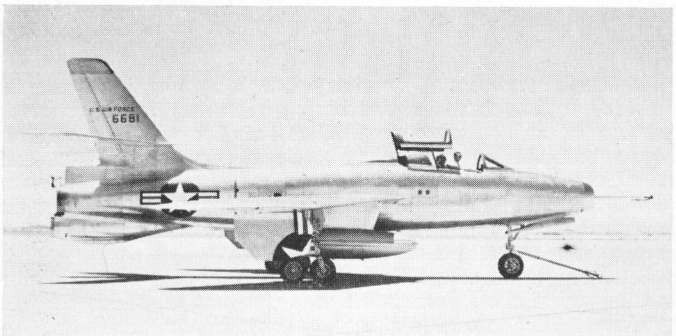
As the ramjet has no static thrust—the combustible mixture being compressed by forward speed alone—the Leduc 010 was carried to altitude by a " parent " transport for launching. Gliding tests were commenced in October 1947, and the first powered flight was made on April 21, 1949. During early flight testing a speed of 505 m.p.h. was attained at 36,000 ft., with the ramjet delivering half thrust. A second machine, the Leduc 010–02, was built, and in February 1951 a third and similar machine, the Leduc 016, was completed.

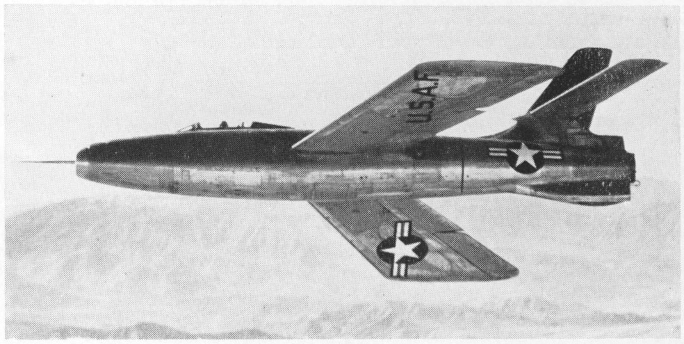
It was initially proposed that the Leduc 016 should have a 660 lb. thrust Turboméca Marboré I turbojet at each wing-tip for standby power, but this plan was abandoned and mass balances were installed in place of the turbojets.

The Leduc 010 is limited to Mach 0·84, at which speed the ramjet furnishes 4,400 lb. thrust, and this Mach number is maintained in the climb with a rate of 7,800 ft./min. at 29,000 ft. Normal loaded weight is 6,615 lb. Dimensions: span, 34 ft. 5½ in.; length, 33 ft. 7½ in.; wing area, 172·1 sq. ft.

(Below, left) *The Leduc 016.* (Below, right and g.a. drawing) *The Leduc 010–01*







The experimental Republic XF–91 (46–681) fighter with variable-incidence wing and rocket boost.

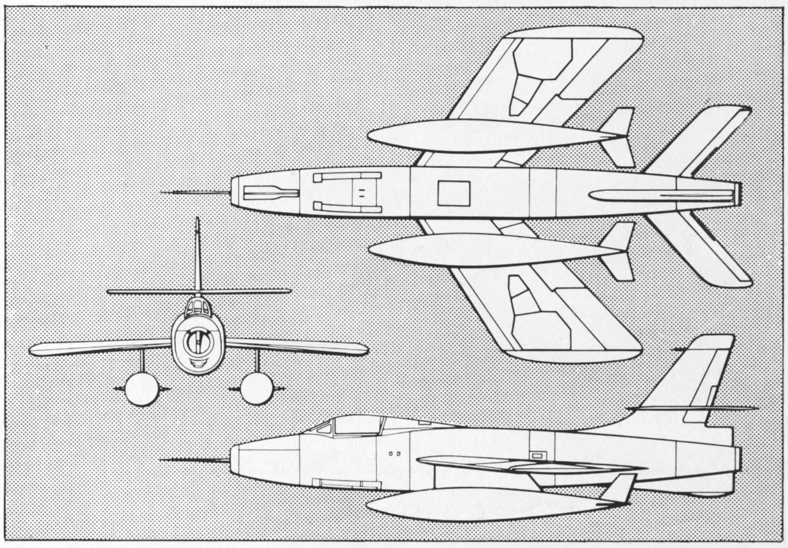
REPUBLIC XF–91 (MAY) 1949

Designed initially as a high-altitude interceptor fighter, the Republic XF–91 embodied several unusual design features, most striking of which was undoubtedly the variable-incidence swept wing with inverse taper and thickness. The variable incidence of the wing permitted a high angle of attack for take-off and landing. The inverse taper combined with leading-edge slots reduced wing-tip stalling at low speeds, the wing having greater chord and depth at the tips than at the fuselage intersection, providing most lift outboard. Because of the thin wing root the undercarriage was retracted outboard, the tandem high-pressure wheels lying in the wingtips.

The XF–91 flew for the first time on May 9, 1949, and was powered by a 5,200 lb. thrust General Electric J47–GE–3 turbojet which could be augmented for short periods by the thrust of a Reaction Motors XLR–11–RM–9 rocket motor installed in the rear fuselage in addition to an afterburner extension. The four rocket tubes were disposed two above and two below the tailpipe and gave 6,000 lb. thrust.

After prolonged flight trials, in December 1952 the XF–91 exceeded Mach 1·0 in level flight on the combined power of its turbojet and rocket unit and thus became the first U.S. combat aircraft so to do. No production order for the XF–91 was placed by the U.S.A.F., but experience gained with this aircraft is being embodied in later machines.

No performance data appertaining to the XF–91 has been revealed. Its overall dimensions include a wing span of 31 ft. 3 in., a length of 46 ft. 8 in., and a height of 18 ft. 1 in. Maximum loaded weight, 30,000 lb.

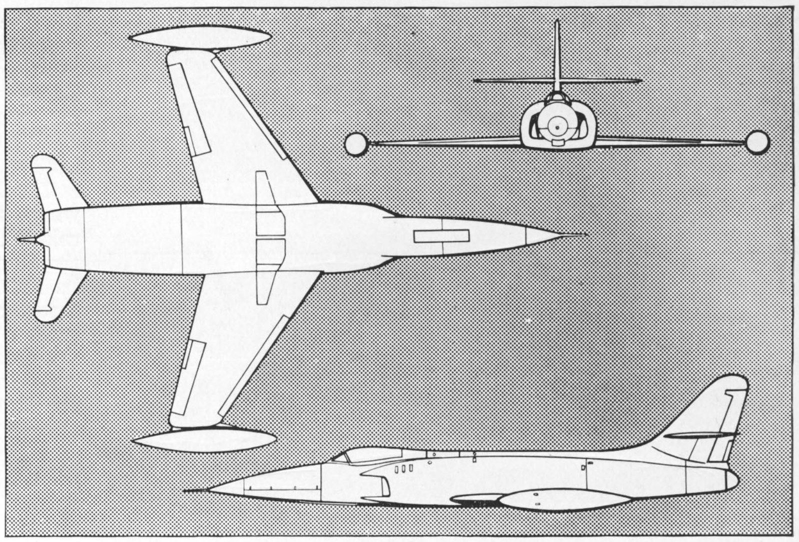


LOCKHEED (MODEL 153) XF–90 (JUNE) 1949

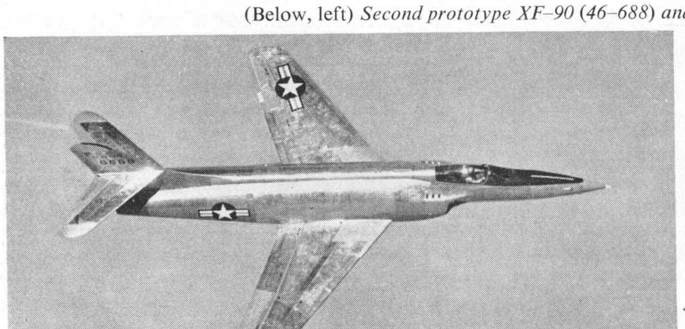
Conceived in 1946 as a heavy, single-seat, long-range fighter, the XF-90 was the second U.S. jet aircraft designed to fulfil the so-called "penetration" role, suitable for both escort duties and tactical army support. Powered by two Westinghouse J34-WE-11 turbojets mounted side by side in the fuselage and providing 3,600 lb. thrust (and 4,200 lb. thrust with short afterburners) each, the XF-90's normal loaded weight was some 26,000 lb. A considerable proportion of this weight was made up of fuel contained internally and in jettisonable wing-tip tanks which gave the XF-90 an exceptional operating range exceeding 2,300 miles, but, underpowered, the high-speed performance was not exceptional and changes in operational requirements led to the abandonment of further development in 1950.

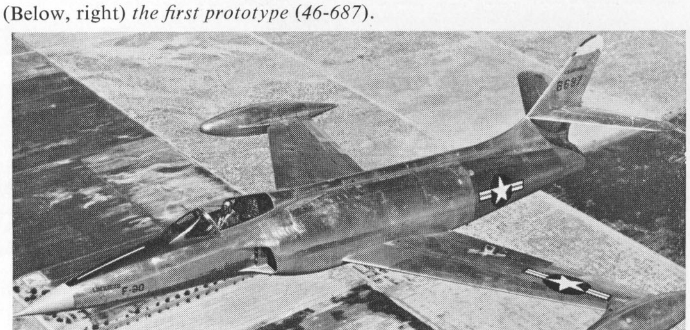
The first of two XF-90 experimental fighters flew on June 4, 1949, and incorporated several features resulting from supersonic wind-tunnel tests. The low-wing had a maximum thickness of 8 per cent of the chord and was swept 35°. Span and wing area were 40 ft. and 345 sq. ft. respectively, and wing loading exceeded 75 lb./sq. ft. The fuselage possessed a long, slender nose of circular section, and aft of the side air intakes a horizontal elliptical cross-section to house the turbojets and their tailpipes side by side. All tail surfaces were swept. Length and height were 55 ft. and 15 ft. respectively.

Although neither prototype was fitted with a built-in armament, projected forward-firing armament comprised six 0.50-in. or four 20-mm. guns. Various underwing ordnance loads could be carried for the ground-support role.



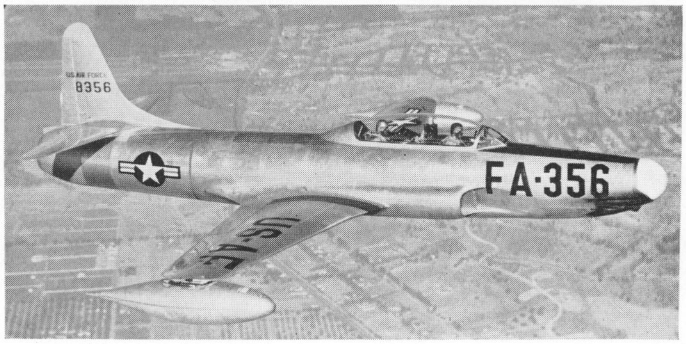
(Below, left) *Second prototype XF–90 (46–688) and* (Below, right) *the first prototype (46-687).*



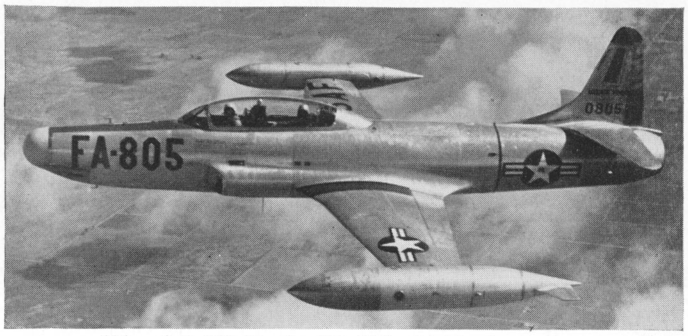


LOCKHEED F–94 STARFIRE

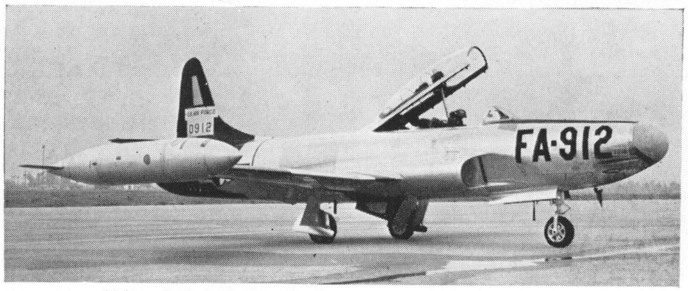
(JULY) 1949



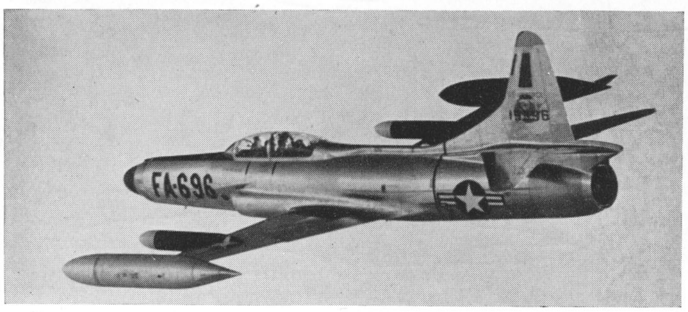
(Above) *F–94A Starfire (48–356) with J33–A–33 turbojet.*



(Above) *F–94B Starfire (50–805) with Fletcher tanks.*



(Above) *F–94B Starfire (50–912) with canopy raised.*



(Above and below) *F–94C Starfire (51–5696) with wing pads.*

The Starfire two-seat all-weather fighter is a pre-eminent example of the way in which a sound basic design may be progressively developed and adapted to fulfil a role for which it was not conceived. Although strictly a two-seat adaptation of the U.S. Air Force's first operational jet combat aircraft, the single-seat F–80 Shooting Star, the Starfire's continued development has removed all similarity to its precursor, apart from general layout, resulting in virtually a new aircraft.

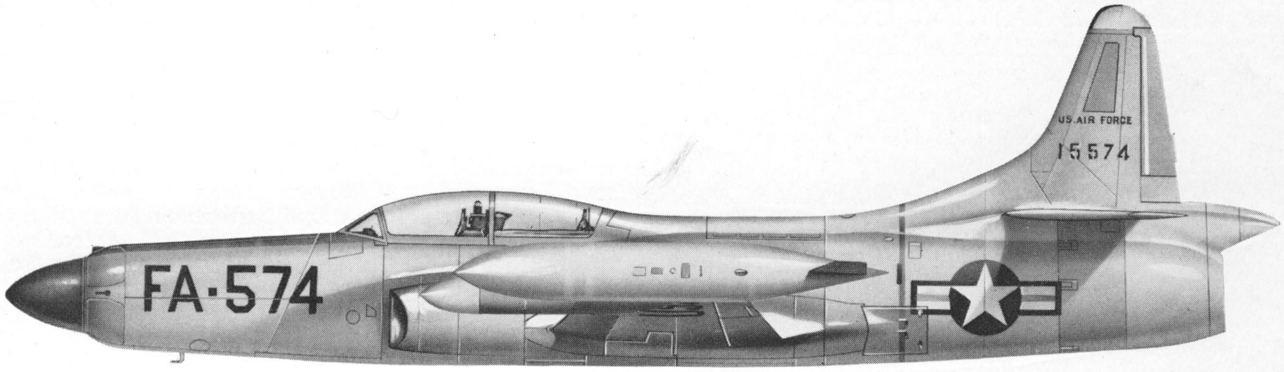
The successful adaptation of the F–80 as a two-seat trainer made logical the investigation of a two-seat all-weather fighter variant. The lateral air intake arrangement facilitated the installation of airborne interception radar in a lengthened nose, and, with a Solar afterburner to improve take-off and increase climb rate, an order for 110 aircraft was placed by the U.S.A.F. in December 1948 under the designation F–94A.

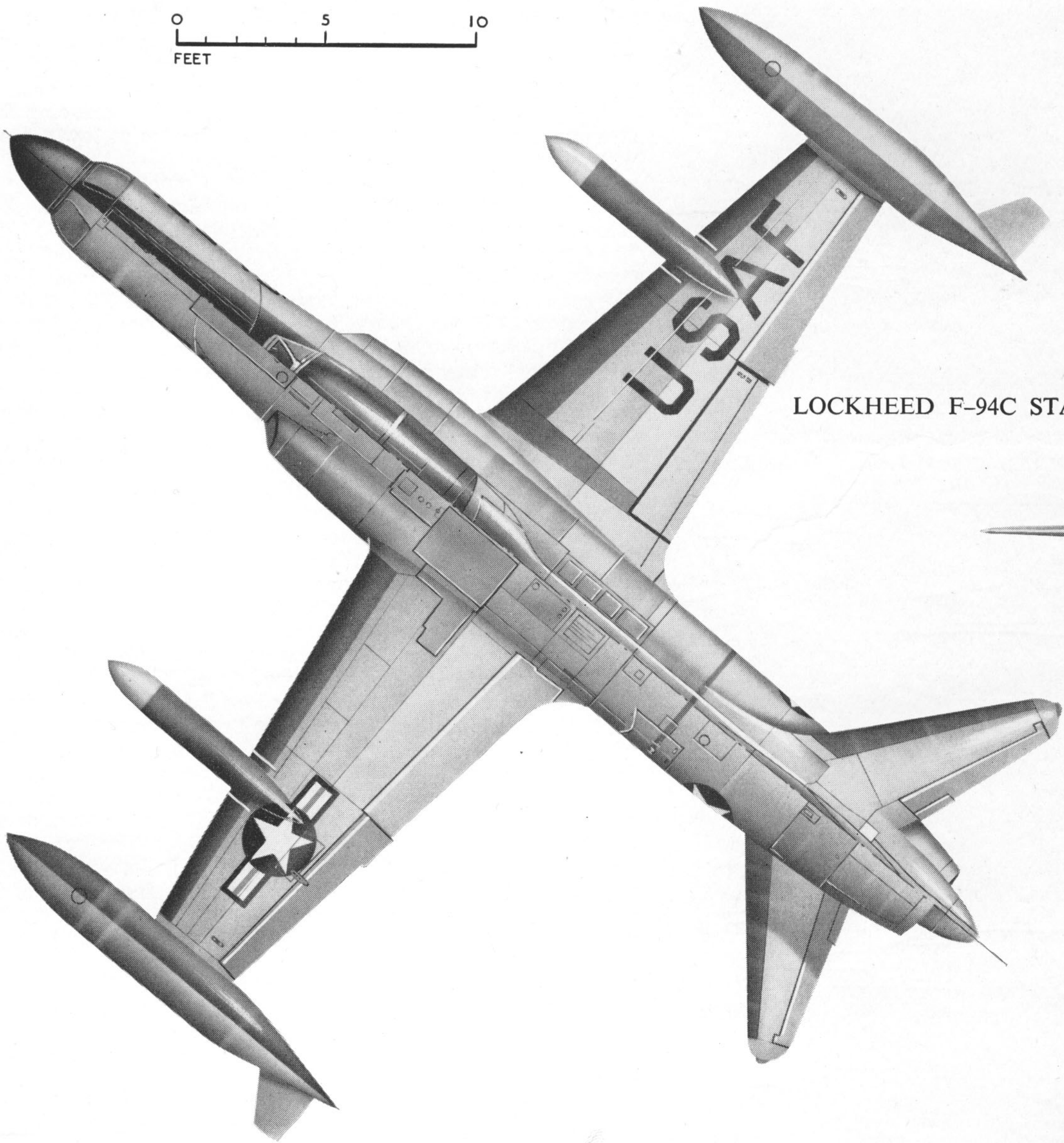
Incorporating 75 per cent standard F–80 assemblies and powered by a 4,600 lb. thrust Allison J33–A–33 turbojet which gave 5,400 lb. thrust with water injection and 6,000 lb. thrust with afterburning, the F–94A (a converted T–33A) flew for the first time on July 1, 1949, production having commenced in January 1949, and the first deliveries were made to the 319th All-weather Fighter Squadron in June 1950. The fuselage nose of the F–94A contained 940 lb. of radar equipment, overall fuselage length was increased to 40 ft. 1½ in. as compared to 34 ft. 6 in. for the F–80C Shooting Star, and wing span and height were 38 ft. 10½ in. and 12 ft. 8 in. Wing area remained 237 sq. ft., and the loaded weight of 15,710 lb. increased wing loading to some 70 lb./sq. ft. for take-off. Armament comprised four 0·5-in. M–3 guns in the fuselage nose.

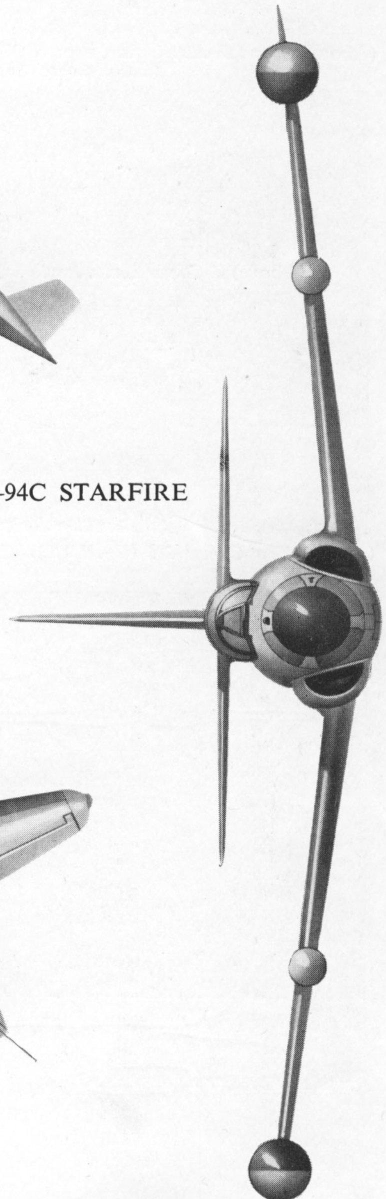
The installation of the second seat necessitated some sacrifice of internal tankage, and the increased fuel consumption resulting from afterburning severely restricted the range and endurance provided by the 539·5 Imp. gal. fuel (including jettisonable wing-tip tanks) carried by the F–94A. In addition, high-altitude performance was inadequate, resulting in the decision to install a more powerful engine and employ a thinner wing. Endurance was to be increased by the use of new 191·5 Imp. gal. Fletcher auxiliary tanks. The new model was initially designated F–94B, but the modifications were so extensive that the variant was redesignated F–97A. In the meantime, 150 improved F–94A Starfires were ordered. These incorporated the new Sperry Zero-Reader and carried Fletcher auxiliary tanks centrally mounted on the wing-tips. This improved F–94A became the F–94B, and in July 1950 the F–97A was again redesignated as the F–94C.

The F–94C differed extensively from its predecessors. The wing was reduced in thickness from 13 per cent to 10 per cent, which raised the critical Mach number from 0·80 to 0·85, enabling the Starfire to make full use of the increased power provided by its Pratt and Whitney J48–P–5 turbojet, which gave 6,250 lb. thrust and 8,300 lb. thrust with afterburning. Owing to its greater thickness/chord ratio the tailplane had to be swept to avoid compressibility problems at high speeds. The fuselage nose was lengthened, early models having a rounded di-electric nose cap later replaced by a pointed fairing. The fuselage nose contained 1,200 lb. of electronic equipment, including automatic locating, tracking and firing instruments, Westinghouse auto-pilot, Sperry Zero-Reader, ILS, etc. Overall dimensions were: span, 37 ft. 4 in.; length, 41 ft. 5½ in.; height, 12 ft. 7 in. Maximum loaded weight was increased to 27,000 lb., and wing loading at take-off was of the order of 115 lb./sq. ft.

The F–94C Starfire was the first U.S. service fighter to dispense entirely with a fixed gun armament in favour of rocket projectiles. Twenty-four 2·75-in. folding-fin Mighty Mouse rockets were housed in a ring of firing tubes around the radar nose fairing behind a retractable shield, and a further twelve 2·75-in. rockets could be housed in each of two cyclindrical fairings projecting from the wing leading-edge at mid-span. The fibreglass noses of the pods disintegrate before the missiles leave their containers. An alternative armament of Hughes F–98 Falcon self-homing missiles can be carried by the DF–94C (the "D" signifying missile-director). The F–94C has a maximum speed of 646 m.p.h. at sea level and, with afterburning, an initial climb rate of approximately 9,250 ft./min. Maximum range is 1,600 miles. A total of 279 F–94C Starfires were built, production being completed in February 1954. The F-94D was a single-seat ground-attack model, development of which was cancelled.

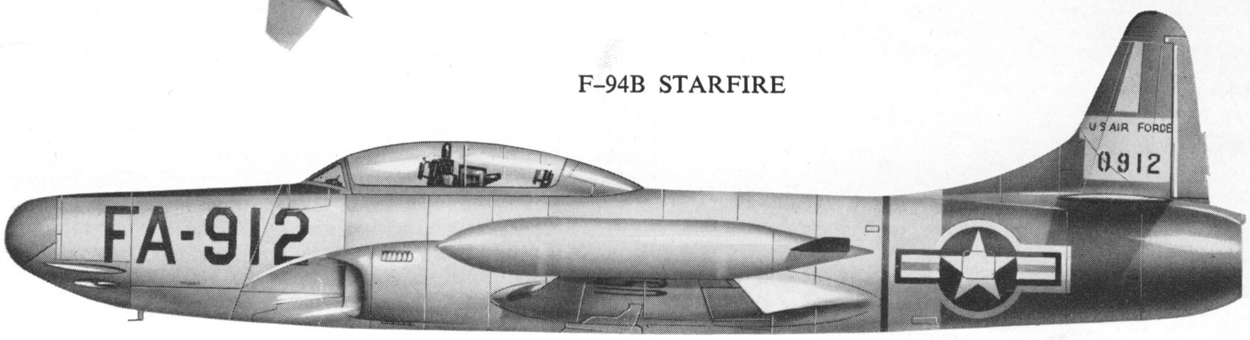






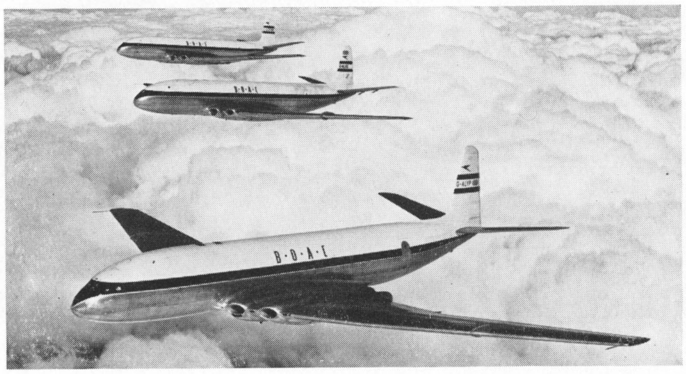
LOCKHEED F–94C STARFIRE

F–94B STARFIRE

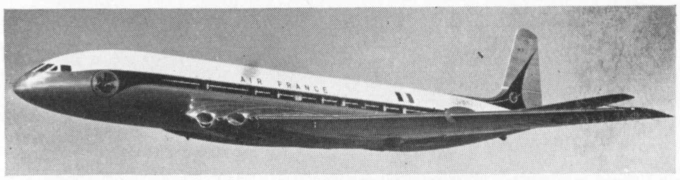


DE HAVILLAND D.H.106 COMET

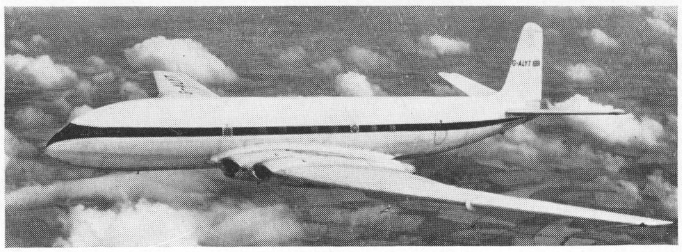
(JULY) 1949



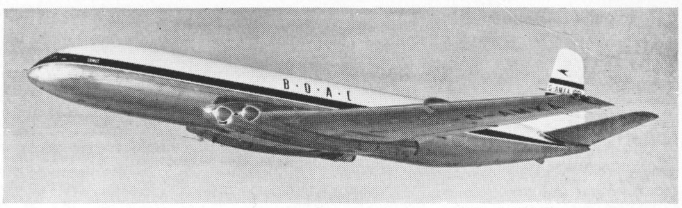
(Above) *First (G–ALVG) and second (G–ALZK) prototypes and first production Comet Series 1 (G–ALYP).*



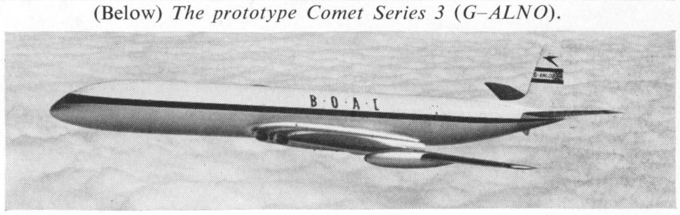
(Above) *A Comet Series 1a (F–BGNX) in Air France livery.*

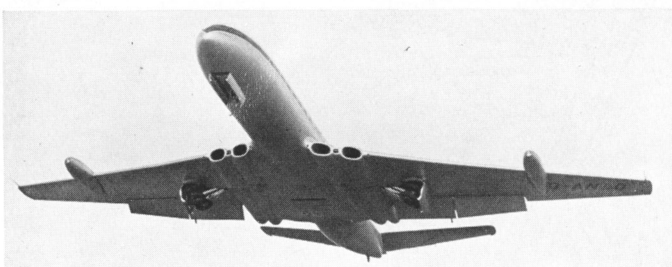


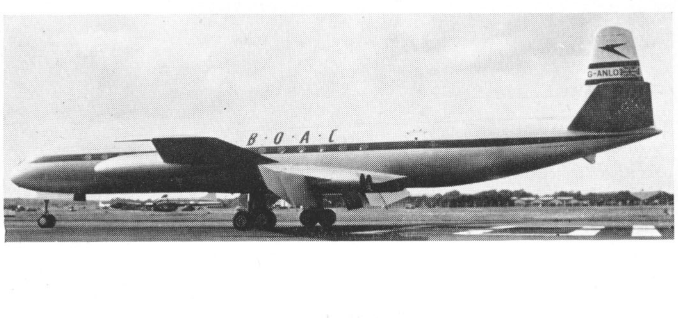
(Above) *The Comet 2X (G–ALYT).* (Below) *First production Comet 2 (G–AMXA).*



(Below) *The prototype Comet Series 3 (G–ALNO).*







Few aircraft have given rise to so much discussion, both from the operational and engineering viewpoints, than has the D.H.106 Comet, the world's first turbojet-driven commercial airliner. The misfortunes that befell the initial production model and resulted in its withdrawal from commercial operation were but a temporary setback in the evolution of this historic aircraft and do not detract from the boldness and foresight of its basic design and the outstanding qualities that it evinced in commercial service.

Development of the D.H.106 began in 1943, when the de Havilland Aircraft Company and the Brabazon Committee foresaw the postwar need for an advanced airliner utilising the then new gas turbine engine. The basic configuration of the D.H.106 was finalised in August 1946, an order for sixteen machines was placed in January 1947 and, in December of that year, it was decided to name the D.H.106 the Comet. The first prototype was wheeled out in April 1949, and on July 27, 1949, was flown for the first time.

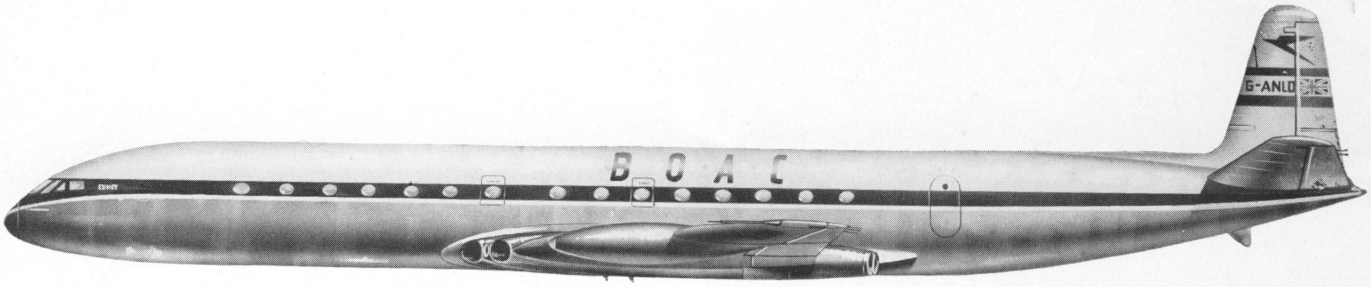
The aesthetic simplicity of the Comet belied the advanced thought in its design. The four turbojets were grouped as close to the fuselage centre line as was possible in order that flight on any two turbojets could be effected without considerable rudder trim correction, thus offering the possibility of reducing fuel consumption while holding a stand-off pattern at low altitude where the turbojet's economy is poor.

The initial production version, the Comet Series 1, was powered by four 5,050 lb. thrust de Havilland Ghost 50 Mk.1 turbojets, the first production aircraft flying on January 1, 1950. The Comet Series 1 had a moderately swept wing (20° at quarter-chord), with a gross area of 2,015 sq. ft., which resulted in a modest wing-loading at the all-up weight of 107,000 lb. Providing accommodation for thirty-six to forty passengers, the Series 1 cruised at 490 m.p.h. at 35,000–42,000 ft. and was employed on international routes in stages of up to 1,300 miles. Ultimate still-air range (with full tankage and 12,000 lb. payload) was 3,540 miles. Overall dimensions were: span, 115 ft.; length, 93 ft.; height, 28 ft. 4½ in. On May 2, 1952, B.O.A.C. began regular operations with the Comet, and in the first year of service with the Corporation the Comet carried 27,700 passengers and flew a total of 104,600,000 revenue passenger miles.

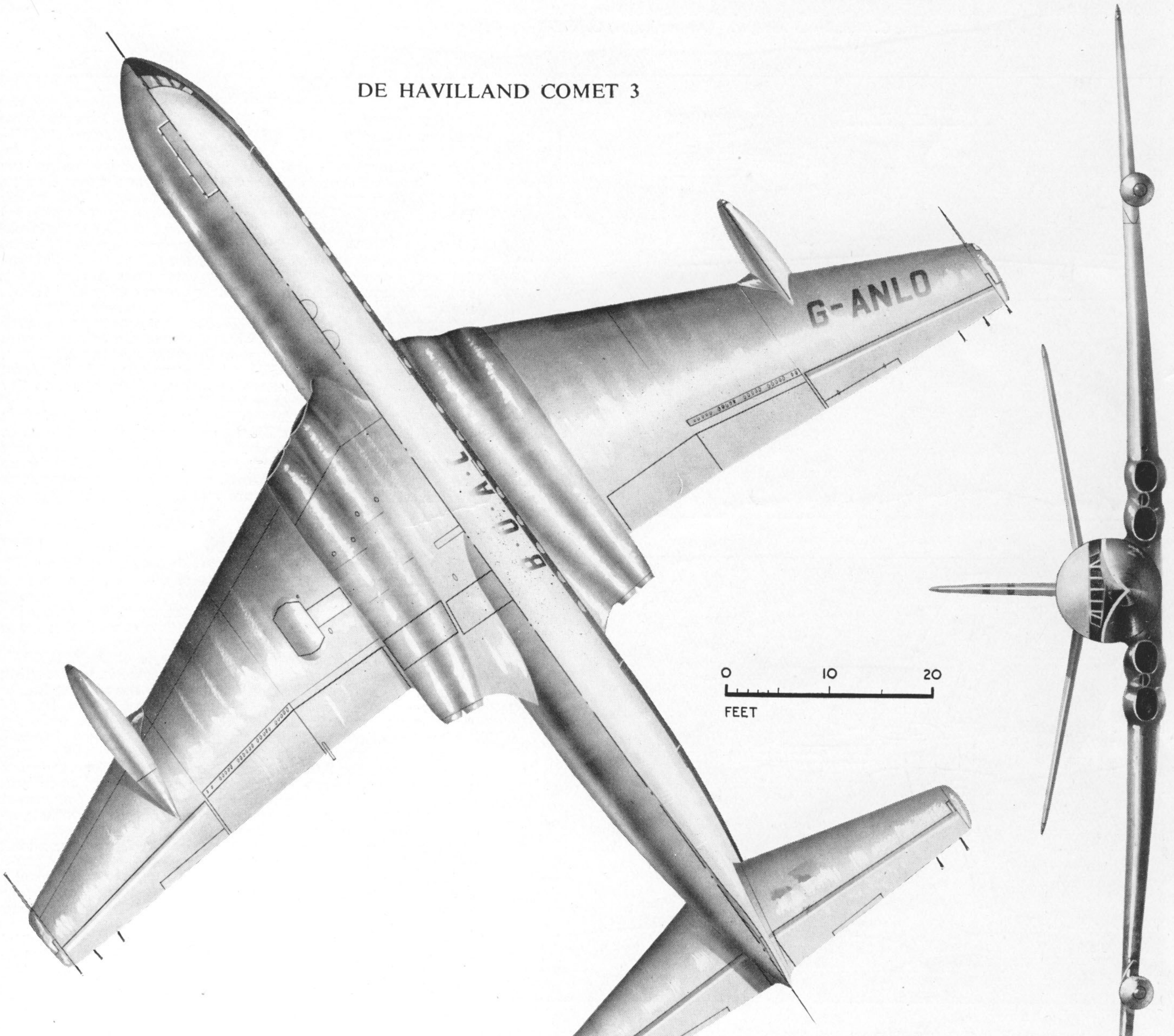
The Comet Series 1a differed in having Ghost 50 Mk.2 turbojets which, with water/methanol injection, provided 5,125 lb. thrust. Fuel capacity was increased from 6,000 to 7,000 Imp. gal., increasing stage lengths by some twenty per cent., all-up weight was increased to 115,000 lb., and seating capacity for forty-four passengers was provided. A total of twenty-three Series 1 and 1a Comets was built, including the prototype.

The Comet Series 1 was succeeded on the production lines by the Series 2, which was a logical development, taking advantage of the higher thrust and lower specific consumption of the Rolls-Royce Avon engine. By taking the sixth airframe from the Comet 1 production line and fitting four 6,500 lb. thrust Avon 502 turbojets, a prototype was produced quickly and, known as the Comet 2X, was flown on February 16, 1952. The production Comet Series 2 differs from the prototype in having 7,000 lb. thrust Avon 503 engines, a 3 ft. increase in fuselage length and a modified wing section to improve take-off characteristics, improve slow-flying performance and reduce the landing speed. The first production Comet Series 2 was flown on August 27, 1953, and this version provides accommodation for forty-four passengers, is suitable for stage lengths of 1,750–2,200 miles, and has a capacity payload of 13,000 lb. Empty and loaded weights are 53,870 lb. and 120,000 lb. respectively, and normal cruising speed is 480 m.p.h. at 40,000 ft.

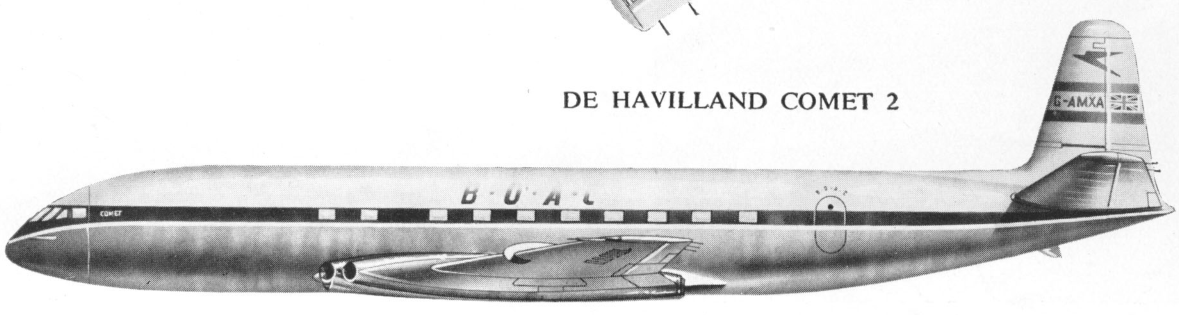
A further progressive development of the basic design, the Comet Series 3, was flown for the first time on July 19, 1954. The fuselage has been lengthened 15 ft. 6 in. as compared to the Series 2, and while the wing plan is essentially the same, there is some increase in wing and flap area, gross wing area being increased to 2,121 sq. ft. A distinctive feature of the wing is the addition of two leading-edge tanks which increase the fuel tankage from 6,900 (Series 2) to 8,050 Imp. gal. The prototype was powered by four 9,000 lb. thrust Avon R.A.16 engines, but the production Series 3 will have the 10,000 lb. thrust Avon 521. Providing accommodation for fifty-eight to seventy-six passengers, the practical stage length with a 17,450 lb. payload will be 2,700 miles. Cruising speed is 500 m.p.h. at 42,000 ft., and loaded weight is 150,000 lb.

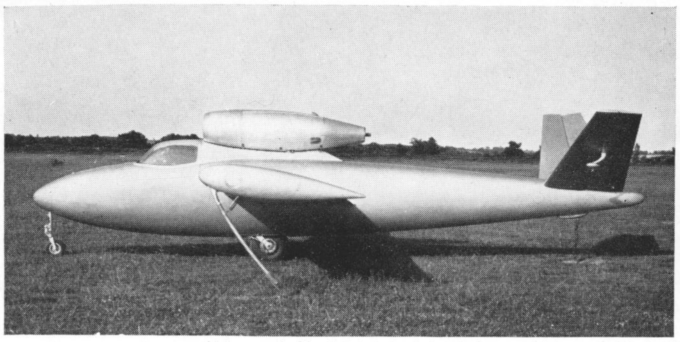
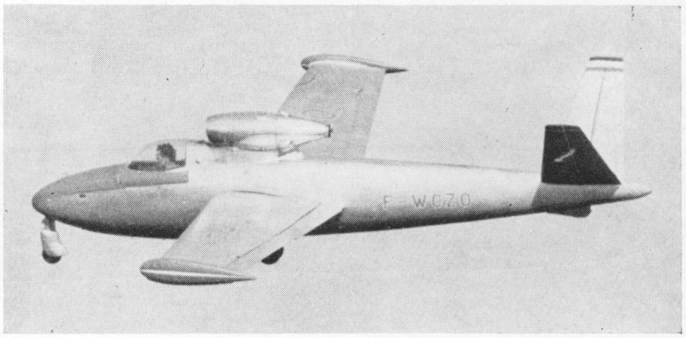


DE HAVILLAND COMET 3

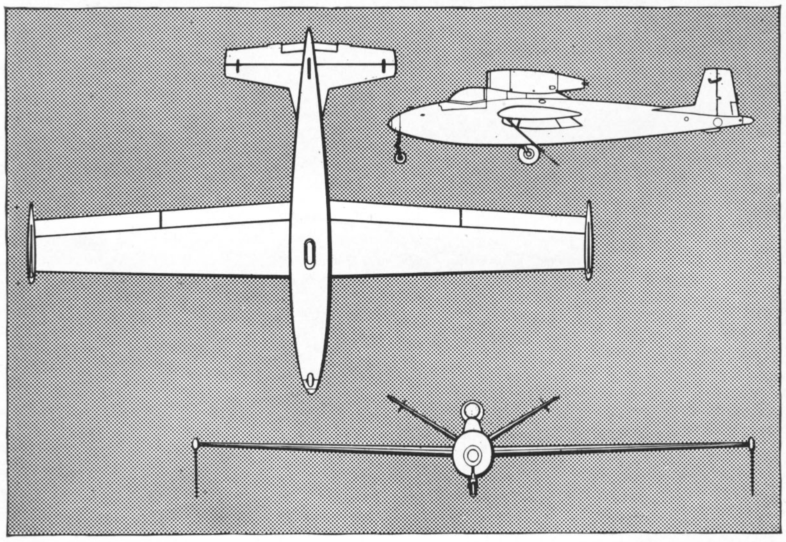


DE HAVILLAND COMET 2



(Above, left) *C.M.8.R–8.3 Midget.* (Above, right) *C.M.8.R–9.8 Cyclope II.* (Drawing) *C.M.8.R–13 Sylphe.*

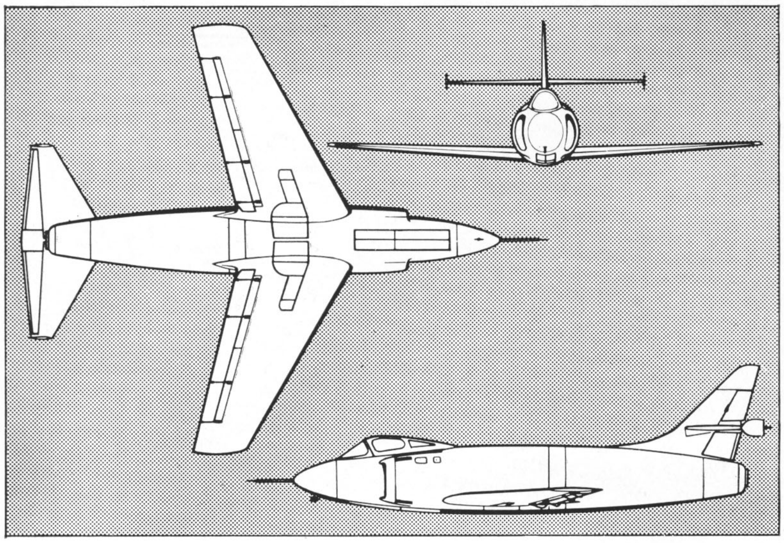


FOUGA C.M.8.R (JULY) 1949

The C.M.8.R. series of light jet aircraft developed by the Établissements Fouga of Aire-sur-l'Adour, France, have stemmed from the C.M.8 glider. The first model, the C.M.8.R-13 Sylphe, was a C.M.8-13 single-seat sailplane with 2,242 lb. thrust Turboméca Piméné turbojet mounted above the fuselage aft of the pilot's cockpit. The Sylphe flew for the first time on July 14, 1949, and was initially intended as a test-bed for the Piméné turbojet. The Sylphe weighed 874 lb. empty and 1,200 lb. loaded. Maximum speed was 163 m.p.h. at 13,120 ft., initial climb rate was 787 ft./min., and maximum range was 200 miles.

A refined, aerobatic development, the C.M.8.R-9.8 Cyclope flew on January 31, 1951. Whereas the Sylphe retained many sailplane characteristics, such as a high aspect ratio wing (13:1), the Cyclope had an aspect ratio of 7·7 : 1, and wing span was reduced from 42 ft. 7½ in. to 28 ft. 9 in. Empty and loaded weights were 867 lb. and 1,220 lb. respectively, maximum speed was increased to 186 m.p.h. and initial climb rate to 945 ft./min. The Cyclope II and III differed in having the 350 lb. thrust Turboméca Palas turbojet which increased top speed to 217 m.p.h., and initial climb rate to 1,575 ft./min.

The Fouga C.M.8.R-8.3 Midjet was a competition aircraft derived from the Cyclope III, with wing span reduced to 23 ft. 2 in. Twelve Midjets were built. The Midjet had an empty weight of 800 lb., and a loaded weight of 1,195 lb. Maximum speed was 217 m.p.h. at sea level, at which altitude range was 108 miles, and initial climb rate was 1,770 ft./min.



AEROCENTRE N.C.1080 (JULY) 1949

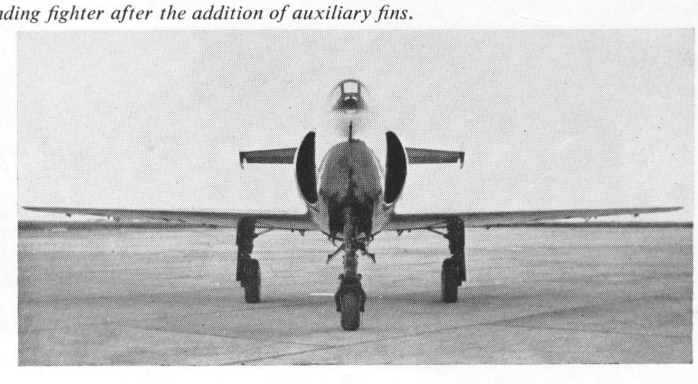
The Aérocentre N.C.1080 single-seat deck-landing fighter was built to meet Aéronautique Navale requirements for a fast, carrier-borne interceptor fighter and fighter-bomber carrying a fixed armament of three 20-mm. cannon, an underwing load of bombs and rockets and sufficient internal fuel tankage to allow for a flight duration of at least 1½ hrs.

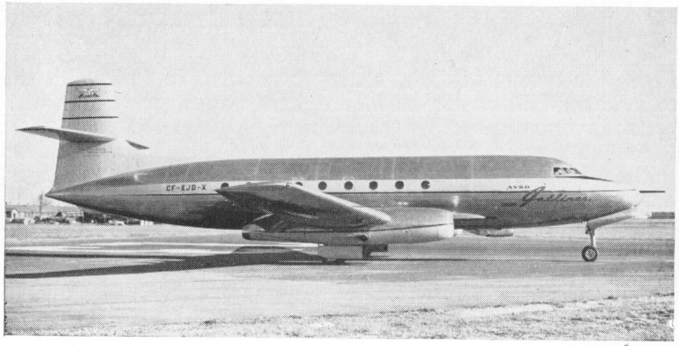
The N.C.1080 was flown for the first time on July 29, 1949. Of all-metal construction, it possessed aesthetically arresting lines which were not marred by the wide scoop-type intake orifices—which conformed to the maximum-beam line of body curvature—close up to the nose and level with the forward-positioned pilot's cockpit. Maximum fuselage diameter was dictated by the smallest dimension which could accommodate the 5,000 lb. thrust Rolls-Royce Nene turbojet; and the wing, which had marked leading-edge taper and moderate trailing-edge sweep, carried no ailerons in the normal sense, lateral control being provided by special Lemoigne-type compensators at the wing tips.

After initial flight trials small vertical surfaces were added to the tailplane tips, but the full capabilities of the N.C.1080 had not been assessed when the sole prototype was totally destroyed. The decision to build the de Havilland Sea Venom under licence led to the abandonment of further development of the type.

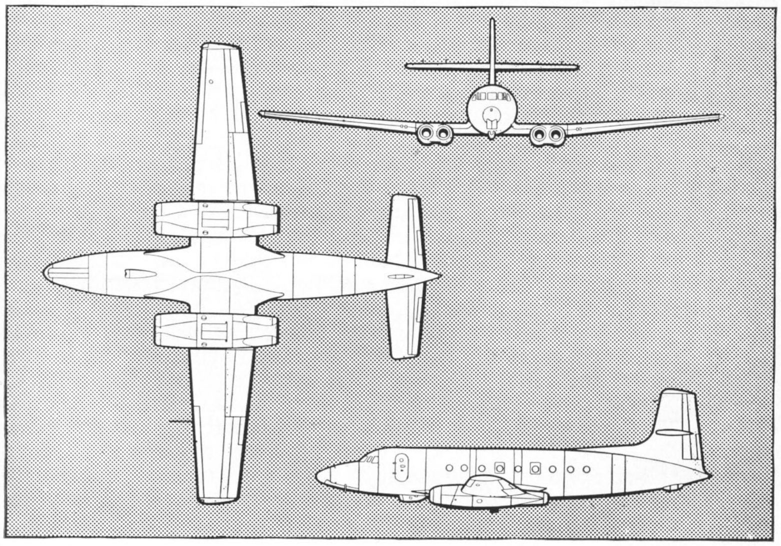
The N.C.1080 had a maximum speed of 584 m.p.h., an initial climb rate of 3,937 ft./min., and a service ceiling of 43,635 ft. Span and length were 36 ft. and 40 ft. 3¾ in. respectively, and wing area was 290·626 sq. ft.

The experimental N.C.1080 single-seat deck-landing fighter after the addition of auxiliary fins.





The C.102 Jetliner (CF–EJD–X) was the first jet transport to be built in North America.

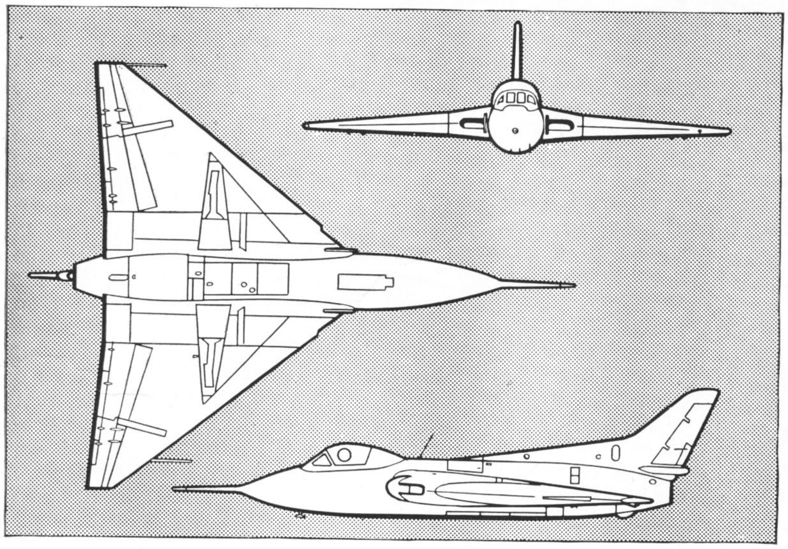


AVRO CANADA C.102 (AUGUST) 1949

Preliminary design work on the C.102 Jetliner was commenced in the summer of 1946 by the Aircraft Division of A. V. Roe Canada Limited. It was initially proposed to employ two Rolls-Royce Avon turbojets, but in the autumn of 1947 when it became apparent that these units would not be available for installation, the design was modified to accommodate four 3,600 lb. thrust Rolls-Royce Derwent 5 turbojets, which at that time possessed the longest overhaul life of any turbojet. In this form the Jetliner flew for the first time on August 10, 1949, becoming the first jet-propelled civil aircraft to fly on the American continent.

The C.102 Jetliner was designed to operate over stage-lengths of the order of 1,100 miles and accommodate a maximum of fifty passengers. A crew of two was carried and all fuel was carried in four integral tanks in the outer-wing sections, total fuel capacity being 2,352 Imp. gal. The C.102 weighed 37,000 lb. empty and 65,000 lb. loaded. Maximum cruising speed was 458 m.p.h. at 30,000 ft., and normal cruising speed was 403 m.p.h. at the same altitude. Maximum and normal climb rates at sea level were 2,220 ft./min. and 1,595 ft./min. respectively, and normal range was 1,250 miles.

It was proposed to increase the fuel capacity of the production model to 4,000 Imp. gal., and preparations were made to produce the Jetliner in limited quantities, but military commitments precluded further development of this promising type. The overall dimensions of the C.102 were: span, 98 ft. 1 in.; length, 82 ft. 9 in.; height, 26 ft. 5½ in.; wing area, 1,157 sq. ft.



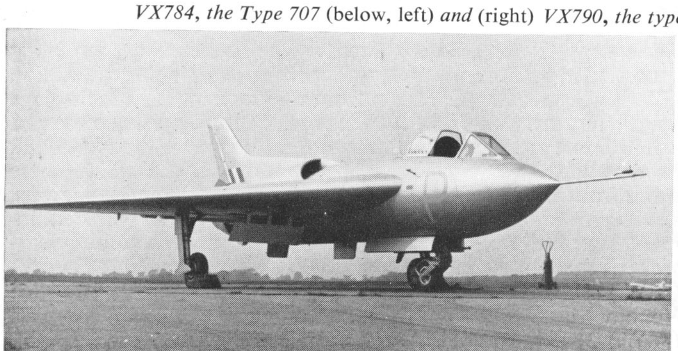
AVRO TYPE 707 (SEPTEMBER) 1949

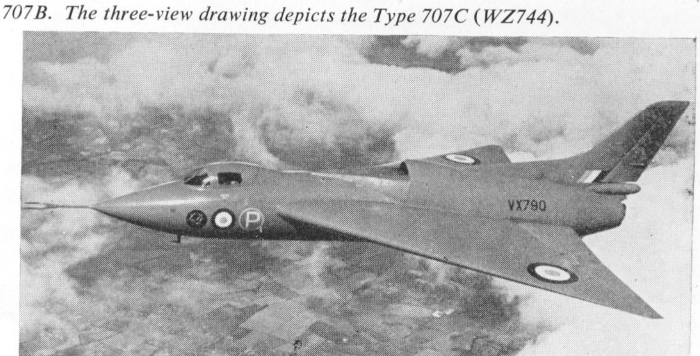
When, in 1948, a specification was issued calling for a medium bomber possessing exceptional load-carrying and range capabilities, A. V. Roe & Co. decided that an aircraft of delta-wing planform in which engines and sufficient fuel tankage could be completely buried in the wing envelope offered the best possibilities for meeting the specification. However, although the high-speed characteristics of the delta-wing were, theoretically, promising, little was known of the low speed behaviour of this planform. Thus, the Type 707 was built as a low-speed one-third-scale model of the projected Type 698 bomber.

Powered by a 3,600 lb. thrust Rolls-Royce Derwent turbojet, the Type 707 flew for the first time on September 4, 1949. This aircraft was totally destroyed during early flight testing, and it was not until September 6, 1950, that a second, modified aircraft, the Type 707B, was available to continue the flight-test programme. Both the Types 707 and 707B were essentially low-speed machines with dorsal air intakes and "low-speed" controls. For higher speeds a third machine, the Type 707A, flew in July 1951. The air intakes were transferred to the wing roots, and the control surfaces were extensively modified.

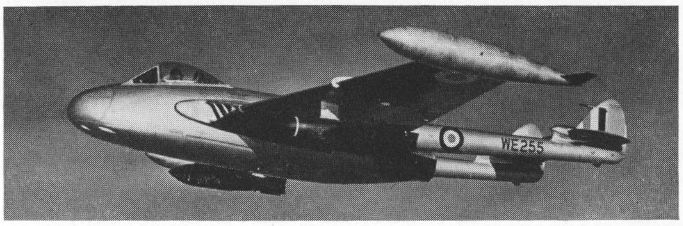
A second Type 707A was later built, and on July 1, 1953, a further variant, the Type 707C, was flown. Although essentially similar to the "A", the "C" was distinguished by its side-by-side seating and, in consequence, a broader cockpit enclosure, and was intended for use in familiarising pilots with the characteristics of delta wings. The Type 707C weighs some 10,000 lb., and overall dimensions are: span, 34 ft. 2 in.; length, 42 ft. 4 in.; height, 11 ft. 7 in.

VX784, the Type 707 (below, left) *and* (right) *VX790, the type 707B. The three-view drawing depicts the Type 707C (WZ744).*

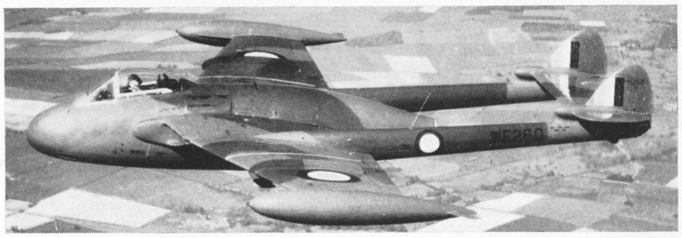


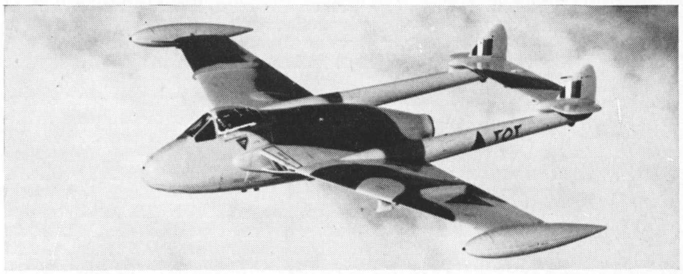


DE HAVILLAND VENOM (SEPTEMBER) 1949

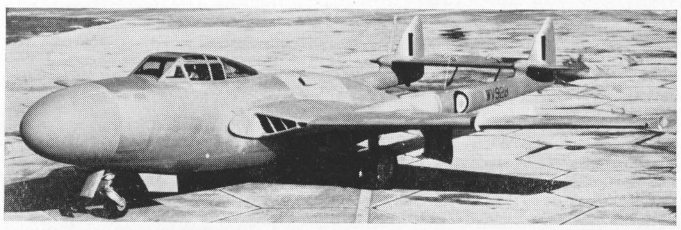


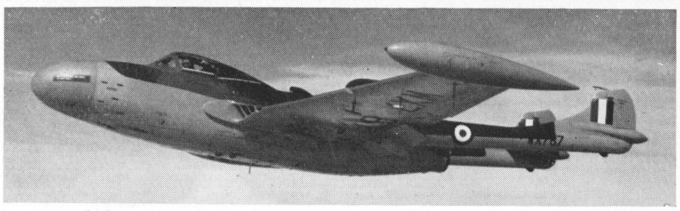
(Above) *Early production Venom F.B.1.* (Below) *Standard production F.B.1.*



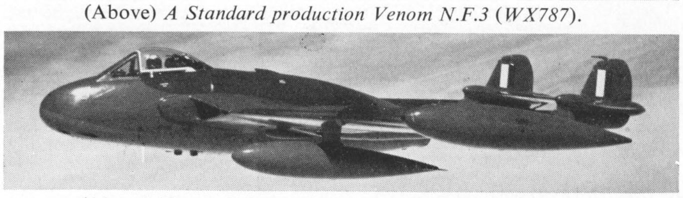


(Above) *Venom F.B.50 and* (below) *a prototype Venom N.F.3* (*WV928*).

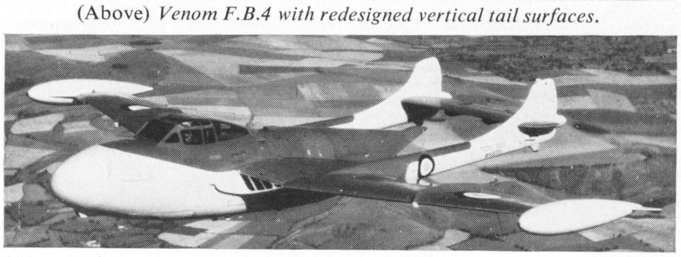




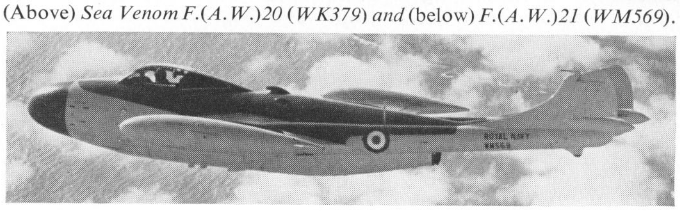
(Above) *A Standard production Venom N.F.3* (*WX787*).



(Above) *Venom F.B.4 with redesigned vertical tail surfaces.*



(Above) *Sea Venom F.(A.W.)20* (*WK379*) *and* (below) *F.(A.W.)21* (*WM569*).



From the results of flight testing conducted in 1947 with the experimental Ghost-powered Vampire it was apparent that, with certain refinements of wing design to increase the permissible Mach number in order that the Ghost's full thrust could be utilised in level flight, the basic Vampire airframe could be adapted for the more powerful turbojet with an appreciable all-round increase in performance. The slightly greater overall diameter of the Ghost as compared to the Goblin did not call for any major alteration to the existing Vampire fuselage nacelle, which, together with a standard Vampire tail unit, was married to a new wing to produce the D.H.112 Venom.

Flown for the first time on September 2, 1949, the Venom had a wing of reduced thickness/chord ratio, incorporating moderate leading-edge sweep and stressed to provide full manœuvrability with full wing-tip tanks. This avoided the necessity of jettisoning the tip-tanks while still containing fuel when joining combat. Built-in armament comprised four 20-mm. Hispano cannon, and provision was made for underwing loads of two 1,000-lb. or 500-lb. bombs, or clusters of anti-personnel bombs, rocket projectiles or napalm tanks. In addition to wing-tip tanks, two 100 Imp. gal. long-range tanks could be carried in place of underwing ordnance loads. Power was provided by a 4,850 lb. thrust de Havilland Ghost 103 turbojet, which provided a maximum speed of the order of 640 m.p.h. at sea level and an initial climb rate exceeding 9,000 ft./min. The Venom was particularly noteworthy for its high-altitude manœuvrability and docile low-speed handling characteristics.

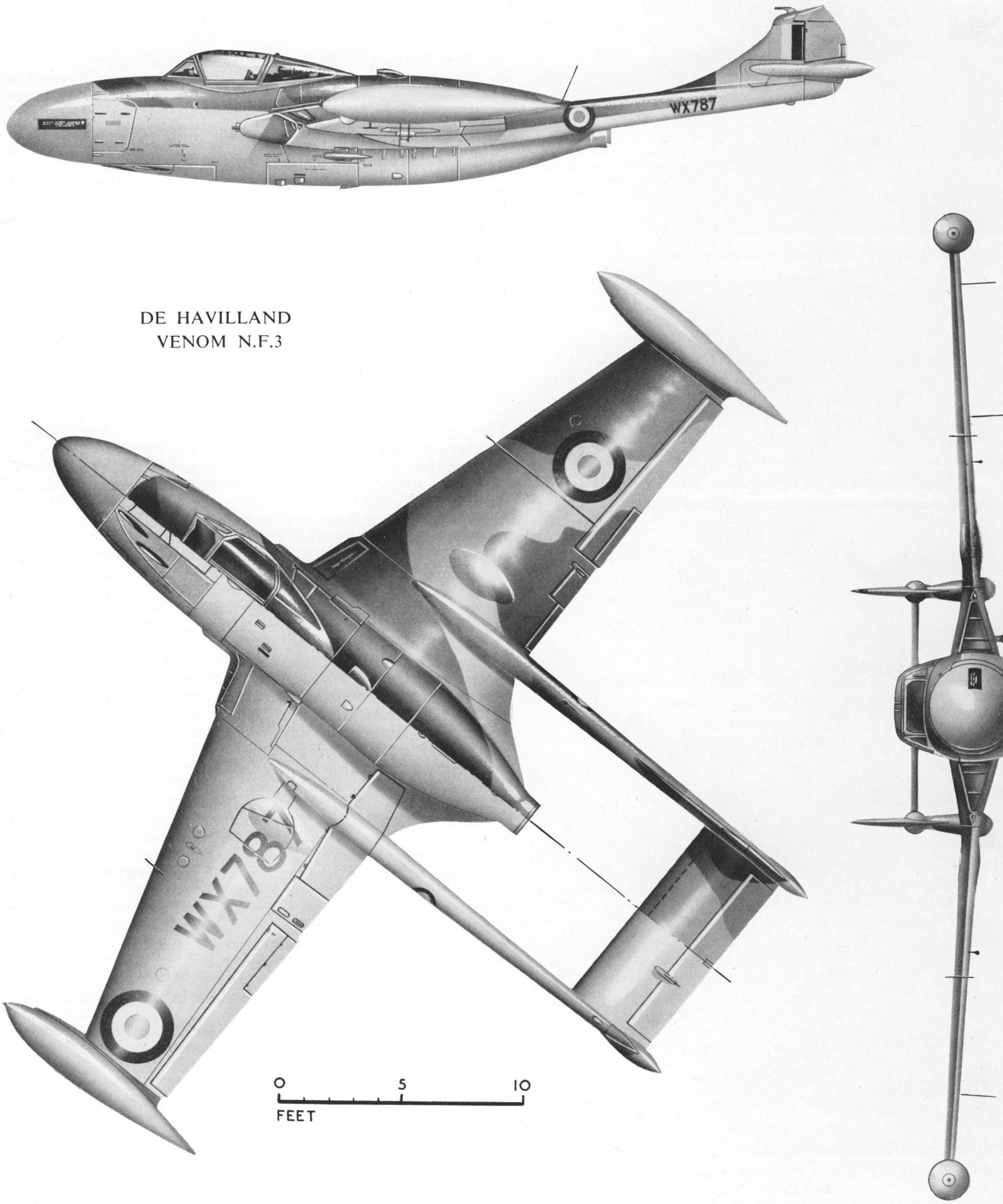
The initial production model was designated Venom F.B.1, and a version of this fighter-bomber is being built under licence in Switzerland for the Swiss Air Force as the Venom F.B.50. The Venom F.B.50 has also been supplied to the Iraqi Air Force. The Venom F.B.1 was followed by a progressive development, the F.B.4, which embodied power-operated ailerons to improve roll-rate and manœuvrability at high Mach numbers, completely redesigned vertical tail surfaces, and an ejector seat for the pilot. Overall dimensions of the Venom F.B.4 are: span 41 ft. 8 in.; length, 33 ft.; height, 6 ft. 8 in.; wing area, 279·8 sq. ft.

Like its precursor the Vampire, the Venom has also been developed as a two-seat night fighter. The two-seat Venom has side-by-side seating for its crew members, the observer seated slightly behind and to the right of the pilot. The built-in armament and wing-tip fuel tanks of the single-seat Venom were retained, and both land-based and carrier-borne variants were ordered as the Venom N.F.2 and Sea Venom F.(A.W.)20, the latter having power-folding wings, catapult points and an arrester hook housed in a fairing above and behind the jet pipe.

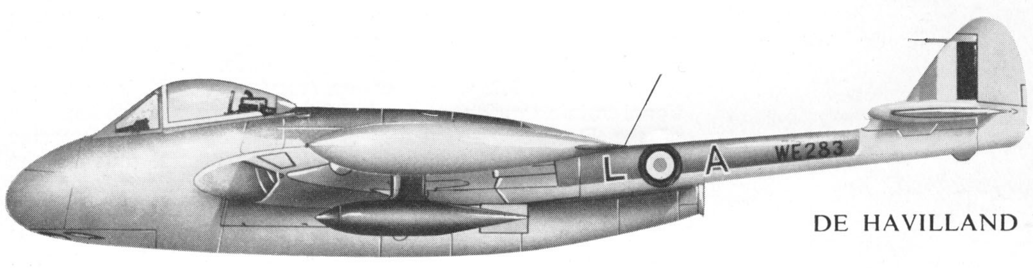
The Venom N.F.2 has been exported to Sweden as the Venom N.F.51, and, as the Aquilon (North Wind), a version of the Sea Venom F.(A.W.)20 is built under licence in France by the Société Nationale de Constructions Aeronautiques du Sud-Est for the French Navy. The first production Aquilon flew on March 25, 1954

The Aquilon is powered by a 4,850 lb. thrust Fiat-built Ghost 48 turbojet, and differs from the Sea Venom in several respects. The cockpit hood slides to the rear, whereas that of the Sea Venom hinges backward, and ejector seats are provided for the crew. The rearward-sliding hood of the Aquilon permits catapult take-offs and carrier landings to be made with the hood open. The cock-pit is fully air-conditioned. The Aquilon has a total fuel capacity of 464 Imp. gal., which is sufficient for a maximum range of approximately 1,000 miles at 32,000 ft. Maximum speed is 587 m.p.h., and minimum speed is 109 m.p.h. Initial climb rate is 8,762 ft./min., and ceiling is 49,200 ft. The seventy-five Aquilons ordered by the French Navy are being produced in both single- and two-seat form, the single-seat version differing little externally, apart from a 60 mm. increase in fuselage length, but carrying modified radar and underwing ordnance loads.

The latest production variants of the Venom are the N.F.3 and its navalised counterpart, the Sea Venom F.(A.W.)21. These differ from their predecessors in having power-operated ailerons, the improved 4,850 lb. thrust Ghost 104, American radar equipment supplied under M.D.A.P., and power-jettisonable clear-view, frameless cockpit canopies. An export version of the F. (A.W.) 21 for the Royal Australian Navy is designated Sea Venom Mk.53. The overall dimensions of the Sea Venom F. (A.W.) 21 are: span, 42 ft. 10 in.; length, 36 ft. 7¼ in.; height, 8 ft. 6 in.; wing area, 279·862 sq. ft.



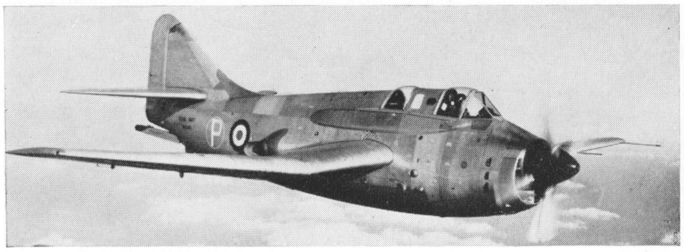
DE HAVILLAND
VENOM N.F.3



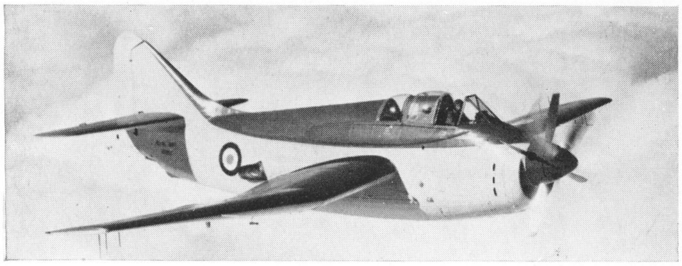
DE HAVILLAND VENOM F.B.1

FAIREY GANNET

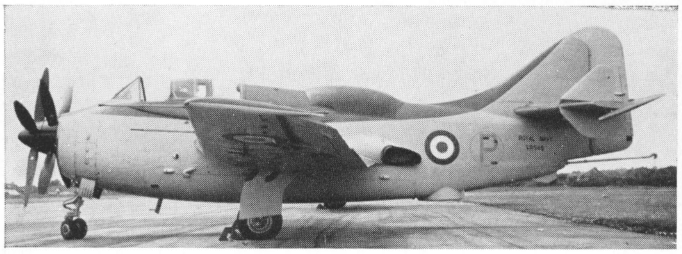
(SEPTEMBER) 1949



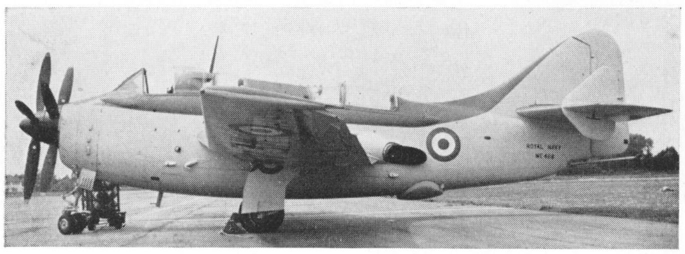
(Above) *First prototype Gannet* (*VR546*).



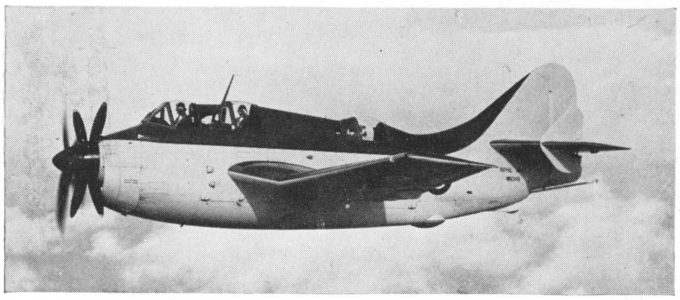
(Above) *Second prototype Gannet* (*VR557*).



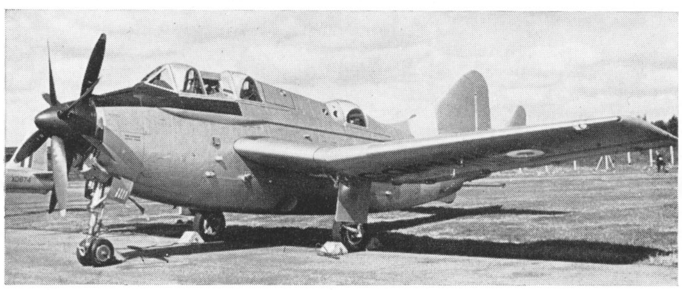
(Above) *First prototype* (*VR546*) *after modification.*



(Above) *Third prototype Gannet* (*WE488*).



(Above) *A production Gannet A.S.1* (*WN346*) *and* (below) *the prototype Gannet T.2* (*WN365*).



Of the many turbine-powered deck-landing naval aircraft developed since the Second World War the Gannet carrier-borne anti-submarine aircraft is undoubtedly one of the most interesting. Its most unusual feature is its double airscrew-turbine unit endowing it with the advantages of a twin-engined aircraft in a single-engined configuration. The Gannet was, in fact, the first aircraft in the world to fly with such a power plant.

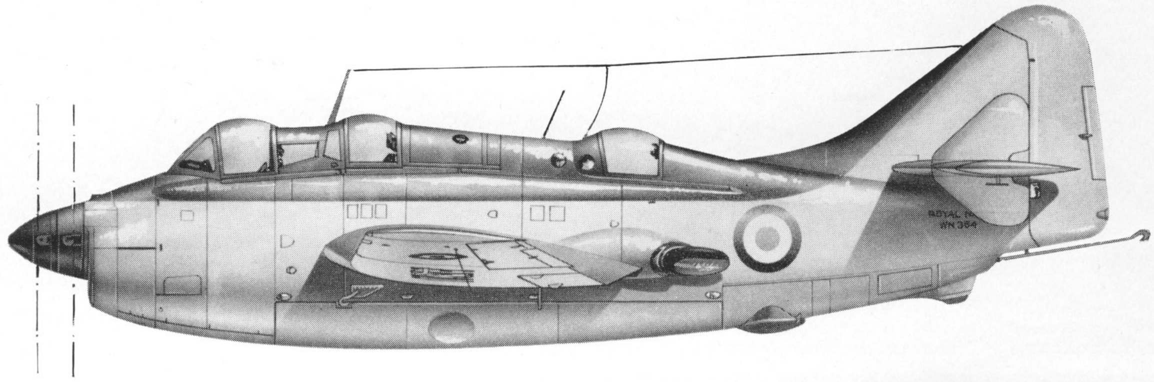
The Gannet was built to meet the requirements of specification G.R.17/45, which called for a two-seat aircraft, the prototype contract being placed on August 12, 1946. The first of two Gannet two-seat prototypes was flown on September 29, 1949, but, in the meantime, numerous changes in requirements had been made by the Admiralty in the light of developments in armament, radar, and operational techniques, resulting in a request for extensive modifications and a third crew member. The third prototype Gannet was completed as a three-seater, flying for the first time on May 10, 1951. The crew arrangement differed from that eventually adopted for the production Gannet A.S.1 in that both navigator and radar operator were carried in the rear cockpit.

The prototypes were powered by the 2,950 e.h.p. Double Mamba A.S.M.D.1, which comprised two Mamba A.S.Ma.3 engines placed side by side and driving independent, co-axial contra-rotating airscrews via a common gearbox. This power plant was developed specifically for the Gannet and possesses several virtues for naval use. Its greatest attribute is that, the power being on the centre-line of the aircraft, endurance can be protracted by using only one of the two engine components for cruising, reserving full power for take-off and combat. This also simplifies landing on one turbine component, whereas a deck landing on one power component of a conventional "twin" must always involve handling problems for the pilot. The aerodynamic design of the Gannet, with regard to wing areas, tail volumes, etc., was, in fact, based on the continuous rating of one component of the Double Mamba. The power plant incorporates reverse-torque mechanism which is, in effect, an automatic airscrew-feathering device, reducing the drag of a windmilling airscrew rapidly. This minimizes the loss in height or speed which occurs while the stationary half of the engine is started and accelerated in the event of the other half failing.

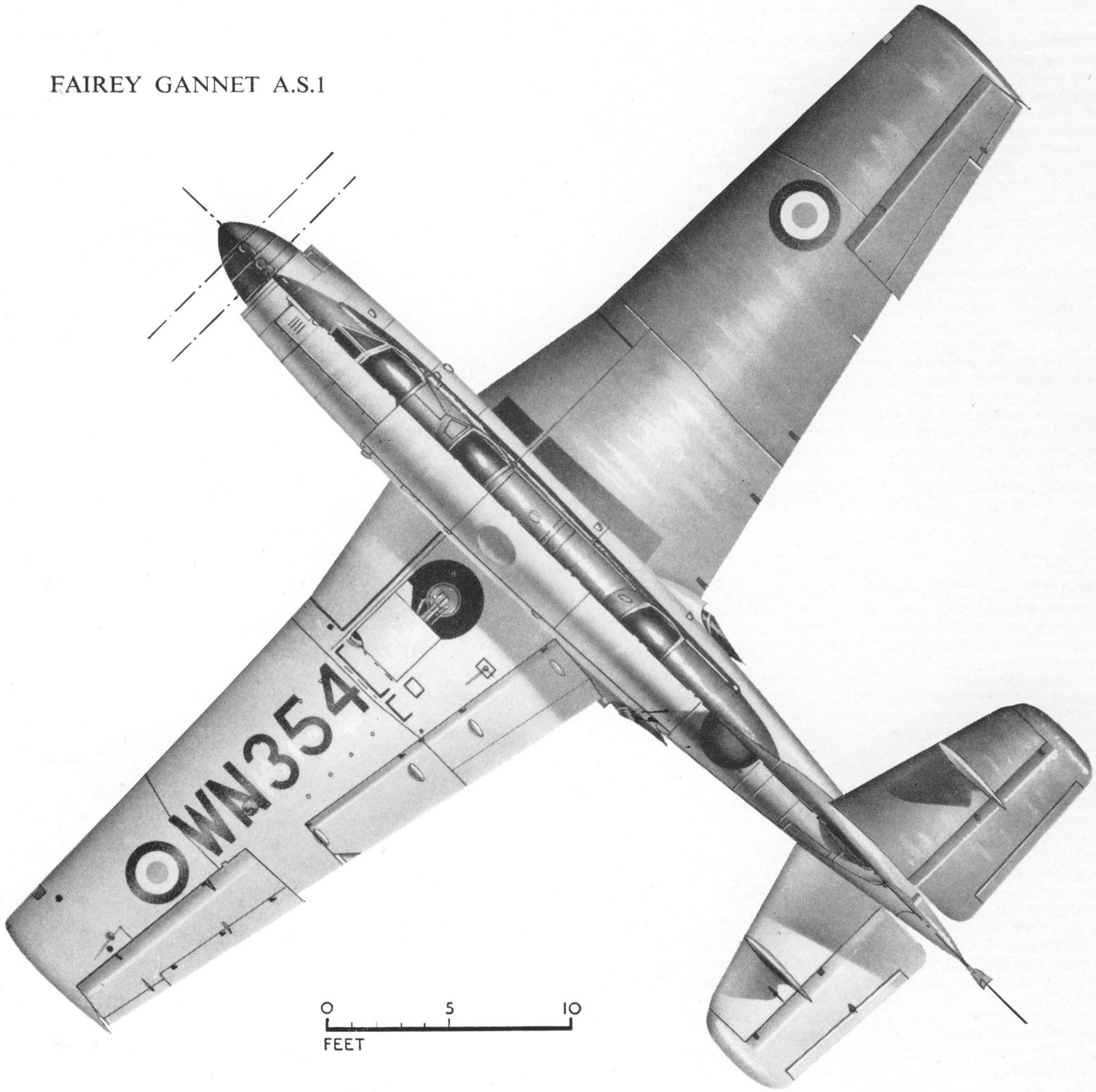
The production Gannet A.S.1, the first of which flew in October 1953, is powered by the 3,190 e.h.p. (2,950 s.h.p. plus 535 lb. residual thrust) Double Mamba (100) A.S.M.D.3. The pilot is seated above the power plant and has an exceptionally good field of view for deck-landing. This field of view is also an invaluable asset during the final stages of an anti-submarine strike, after the radar has indicated the submarine's approximate position. The navigator is seated in a second cockpit immediately aft of the pilot, and the radar operator is seated in a third cockpit over the wing trailing edge. Combining both search and strike roles, the Gannet possesses an exceptionally capacious weapons bay which can accommodate mines, depth charges, bombs or torpedoes. Underwing loads of sonobuoys or rocket missiles can be carried, and a retractable search radar housing is installed aft of the weapons bay.

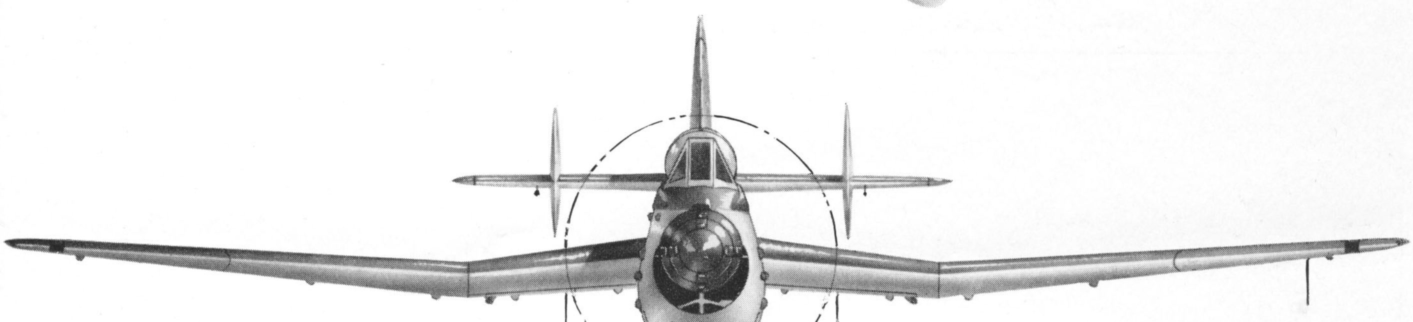
The mid-positioned wing is of cranked form and, to keep stowed height to a minimum, employs a double wing-fold, the inner sections folding up and the outer sections folding down simultaneously. Folded height is 13 ft. 9 in. The tailplane carries auxiliary fins near to centre span, and a tail sting-type arrester hook and catapult points are fitted. The main members of the undercarriage fold inwards into wing bays, and the nose member is of twin-wheel type, this arrangement being governed by the space available under the power plant. Overall dimensions are: span, 54 ft. 4 in.; length, 43 ft.; height, 13 ft. $8\frac{1}{2}$ in. While no official figures for weights and performance have been revealed, the following figures are available from foreign sources: maximum speed, 309 m.p.h.; endurance, 3 hr. 12 min.; empty weight, 12,236 lb.; loaded weight, 17,990 lb.

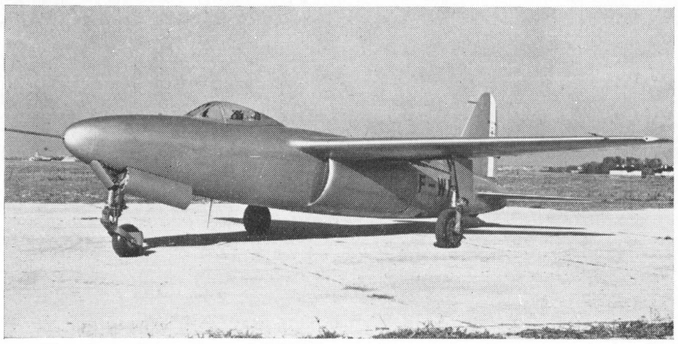
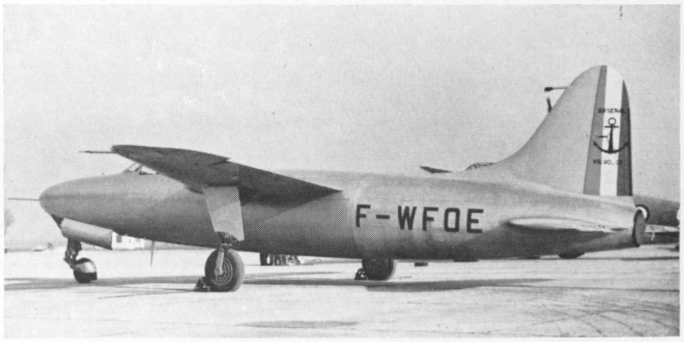
The Gannet T.2, which flew on August 19, 1954, is an operational training variant of the A.S.1 to train crews in the handling of the Double Mamba power plant and in anti-submarine weapons. Except for the deletion of the ventral radome, the Gannet T.2 is externally identical to the operational machine. Provision is made for a pupil in the front cockpit and instructor in the second cockpit with full dual controls. The third cockpit is adaptable to carry either a radio operator or two passengers.



FAIREY GANNET A.S.1

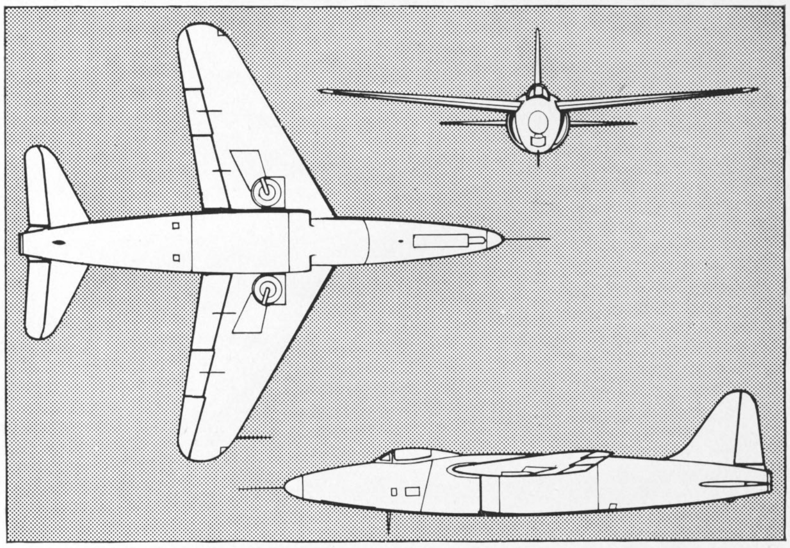




The first of two Arsenal VG 90 experimental single-seat carrier-borne fighters. The VG 90 makes interesting comparison with the VG 70 (page 84).

ARSENAL VG 90 (SEPTEMBER) 1949

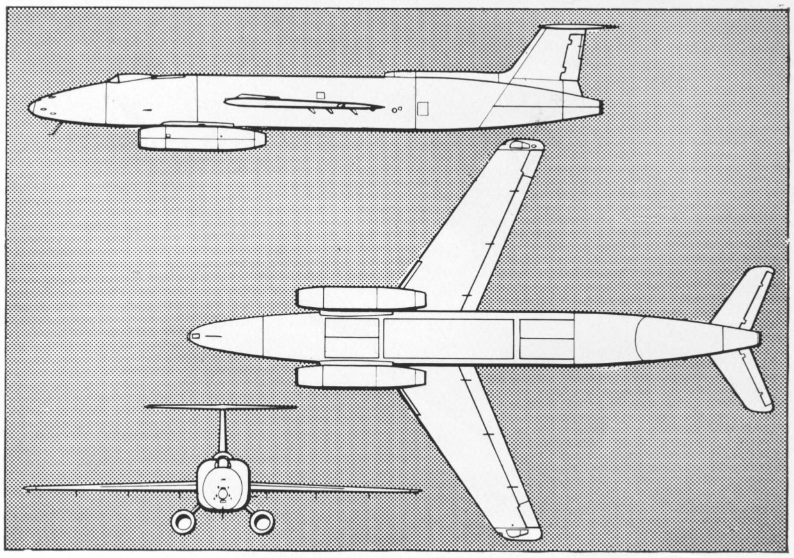


The Arsenal VG 90 was one of three single-seat deck-landing fighters designed to meet the requirements of *Aéronautique Navale*, the other two fighters built to meet this specification being the Aérocentre N.C.1080 and the Nord 2200. Owing much to design experience gained with the VG 70 research aircraft, the VG 90 featured a similar shoulder-wing layout, but sweepback angle at quarter-chord was reduced to 25°. The wing was of Birch plywood stressed-skin Redux-bonded to metal spars and ribs, and the fuselage was an all-metal structure housing an Hispano-Suiza-built Nene centrifugal turbojet of 4,800 lb. thrust.

The first prototype, the VG 90–01, was flown for the first time on September 27, 1949, but was destroyed in an accident on May 25, 1950. A second prototype, the VG 90–02, flew in June 1951 and underwent protracted flight trials at Melun Villaroche, but no production order was placed. It was proposed to replace the Nene by a Hispano-Suiza-built Tay or a S.N.E.C.M.A. Atar 101 turbojet. The attachment of Arsenal ramjet units at the wing tips was also proposed, but no further development was undertaken.

The projected fixed armament of the VG 90 was three 20-mm. Hispano cannon and provision was made for an under-wing load of 2,200 lb. Maximum speed was 596 m.p.h. at 19,680 ft. and 562 m.p.h. at sea level. Initial climb rate was 4,530 ft./min. Empty and loaded weights were 11,420 lb. and 17,800 lb. respectively, and dimensions were: span, 41 ft. 4 in.; length, 44 ft. 1 in.; height, 12 ft. 7½ in.; wing area, 330 sq. ft.

MARTIN XB–51 (OCTOBER) 1949

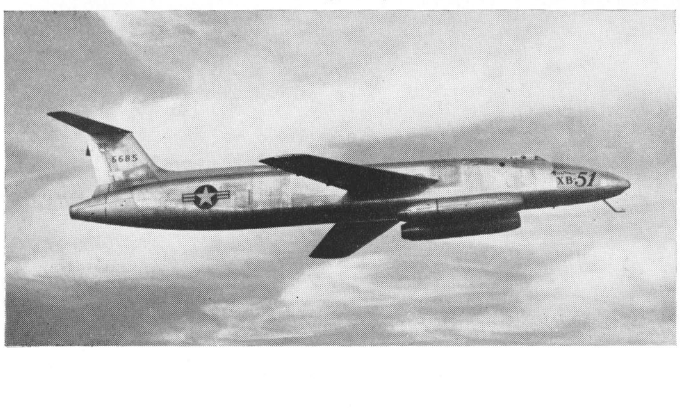


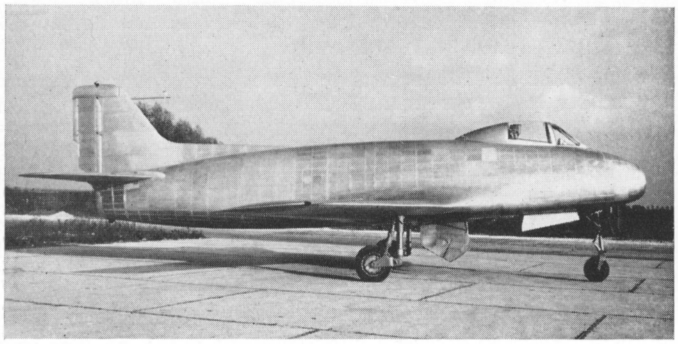
The Martin Model 234, or XB–51, designed to fulfil U.S.A.F. requirements for a specialised low- and medium-altitude assault bomber, was extremely original in conception and embodied several unusual features, not least of which were the number and positioning of the turbojets. It is instructive to note that the role for which the XB–51 was intended is now being fulfilled by the Martin B–57B (Canberra), the British version of which is contemporary with the XB–51, yet, apart from both carrying two crew members, one is the antithesis of the other.

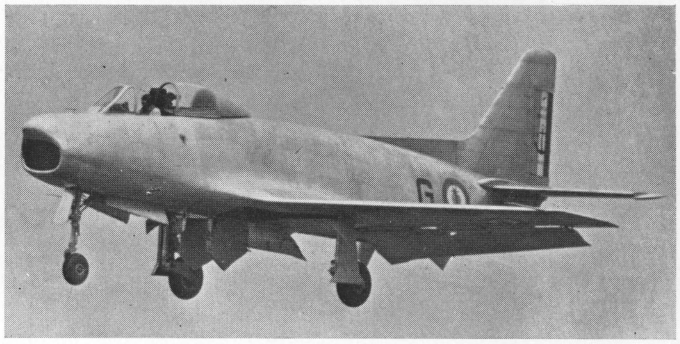
The small wing of the XB–51 was extremely thin and swept back at an angle of 35°. Featuring marked anhedral, this wing was provided with variable-incidence gear, pivoting on the rear spar and allowing take-off and landing in a near-horizontal attitude. Lateral control was effected by spoilers, and large-area slotted flaps extended over most of the span. The thin wing allowed no stowage space, the two double-wheel main undercarriage members retracting into the fuselage and partly accounting for its singular bulk. The first of two XB–51s flew on October 28, 1949, powered by three 5,200 lb. thrust General Electric J47–GE–9 turbojets—two in fuselage-mounted pods and one in the rear fuselage—and the second XB–51, powered by J47–GE–13 turbojets, was completed in the spring of 1950.

The XB–51 had a maximum speed of 620 m.p.h. at sea level and an approximate loaded weight of 80,000 lb. Dimensions included: span, 53 ft.; length, 80 ft.; height, 17 ft. Maximum bomb load was 12,000 lb.

The first of two Martin XB–51 (46–685) three-jet experimental attack bombers.

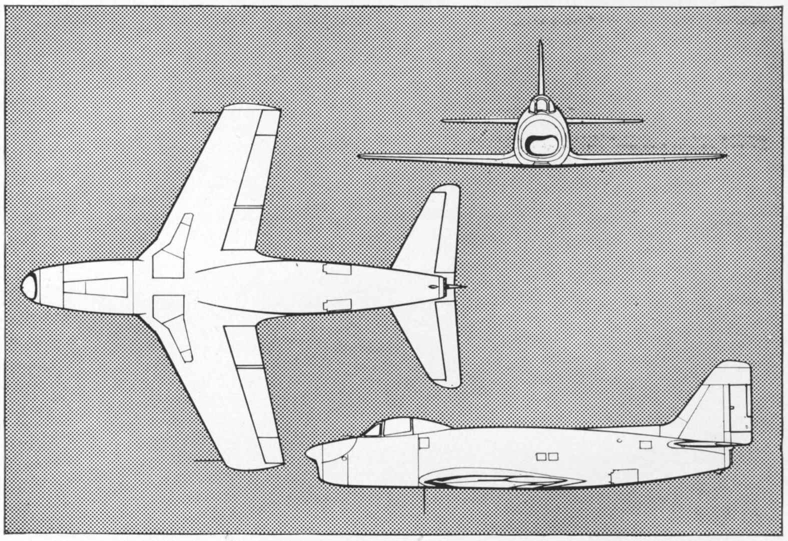






(Above, left) *The Nord 2200 experimental shipboard fighter prior to modification and* (above, right, and drawing) *after modification.*

NORD 2200 (DECEMBER) 1949



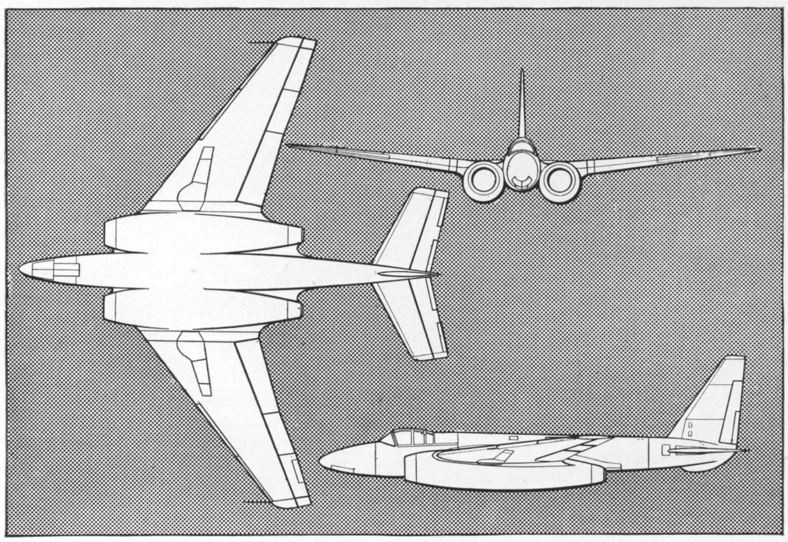
The Nord 2200 prototype, which flew for the first time on December 19, 1949, was designed to meet *Aéronavale* requirements for a single-seat shipboard interceptor fighter.

Powered by a 4,850 lb. thrust Hispano-Suiza Nene 101 turbojet, the Nord 2200 featured a thin, laminar-flow wing swept back 24° and carrying large-span Fowler extension flaps which were coupled with leading-edge slots. Lateral control was by means of diminutive ailerons at the wing-tips coupled with lift spoilers which could be used as air brakes. The fuselage housed all fuel (460 Imp. gal.) sufficient for an endurance of 1 hr. 30 min. at 434 m.p.h. at 39,360 ft., and provision was made for a fixed armament of three 20-mm. or 30-mm. cannon. This could be augmented by underwing loads of two 1,100-lb. bombs or eight rocket projectiles.

After initial flight trials considerable modification was undertaken. A servo control system was installed, the vertical tail surfaces were increased in area and an A.I. radar scanner was mounted over the swollen upper lip of the nose air intake. Flight trials were resumed on March 12, 1952, but no production order was placed. However, an extensive flight-test programme was undertaken with the Nord 2200, furnishing valuable information on the problems associated with the operation of swept-wing aircraft from carrier decks.

In its original form the Nord 2200 weighed 10,626 lb. empty and 17,358 lb. loaded. Performance included a top speed of 581 m.p.h. at 16,400 ft. and 567 m.p.h. at sea level. Initial climb rate was 4,530 ft./min. Overall dimensions were: span, 39 ft. 4 in.; length, 44 ft. 3 in.; height, 15 ft. 2 in.; wing area, 340 sq. ft.

NORD 1601 (JANUARY) 1950



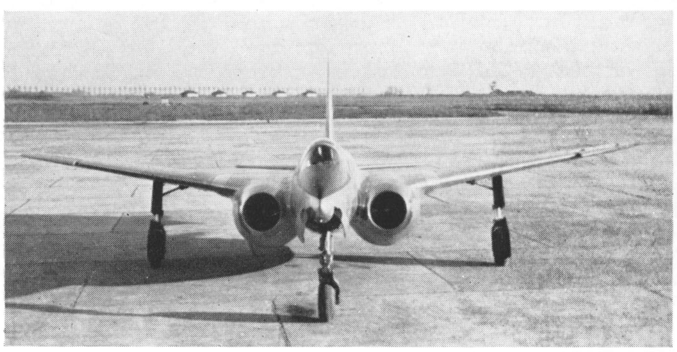
The Nord 1601 was built to investigate the stability of swept wings, the effect of sweepback on high-lift devices, and control and other aerodynamic problems in the subsonic Mach 0·8–0·85 range. Originally intended to have Rateau S.R.A.1 turbojets, the design was adapted for two 3,500 lb. thrust Rolls-Royce Derwent 5 units with which the Nord 1601 first flew on January 24, 1950.

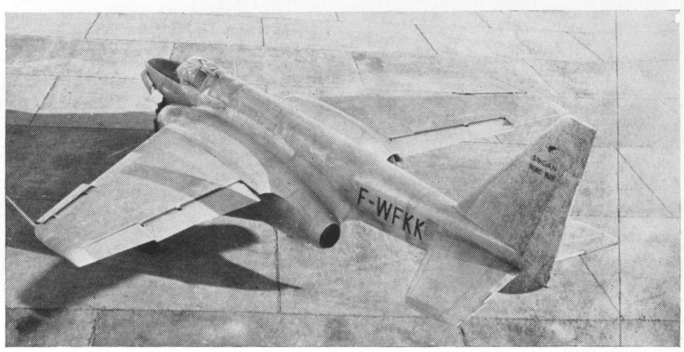
The wing of the Nord 1601 was swept at an angle of 33° and was of thin, laminar-flow section with leading-edge slots and large slotted flaps used with small ailerons supplemented by spoilers. Wing span and area were 40 ft. 5 in. and 325 sq. ft. respectively. The Derwent turbojets were mounted under the wing roots close to the fuselage sides, their proximity to the fuselage centre line favourably affecting performance in the one-engine-out condition. The oval-section fuselage had a length of 38 ft. 9 in. The tail surfaces were swept at an angle of 25°, and overall height was 15 ft. 5 in.

The Nord 1601 had a maximum speed of 621 m.p.h. and an initial climb rate of 6,890–7,870 ft./min. (according to the test instrumentation installed). Service ceiling was 39,360 ft. and loaded weight was 14,740 lb.

An alternative version of the design originally proposed was the Nord 1600 all-weather fighter. Design studies for both single and two-seat variants were prepared, and the Atar 101 turbojet was considered as an alternative power plant to the Rolls-Royce Derwents of the Nord 1601. However, this project did not meet with official support, and the Nord 1600 was not constructed.

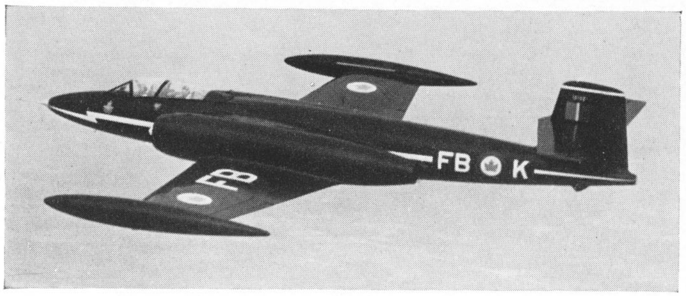
The Nord 1601 single-seat research aircraft was originally designed as a fighter with axial-flow turbojets.



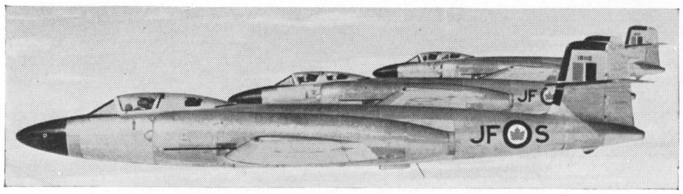


AVRO CANADA CF-100

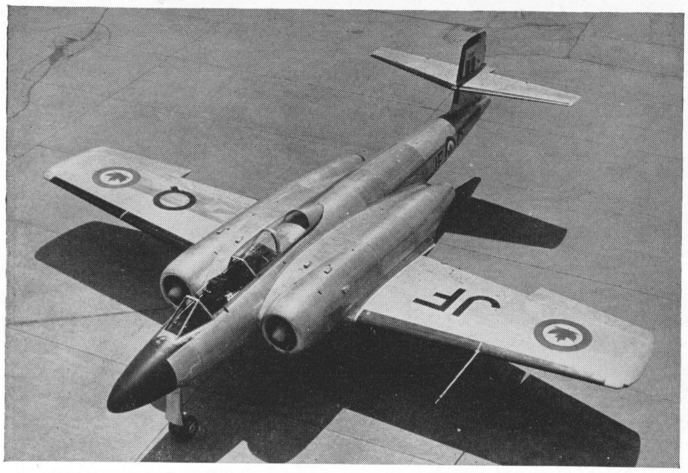
The JET AIRCRAFT of the World (JANUARY) 1950



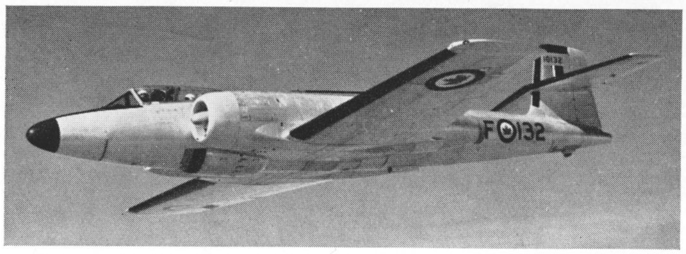
(Above) *The Avon-powered first prototype CF–100 Mk.1.*



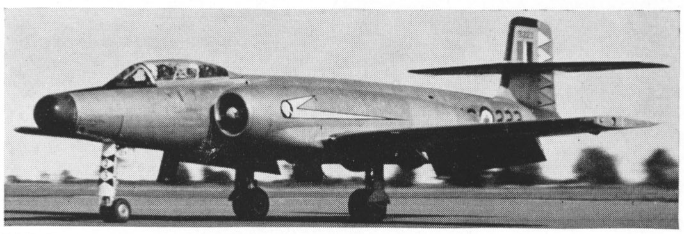
(Above and below) *The pre-production CF–100 Mk.2.*

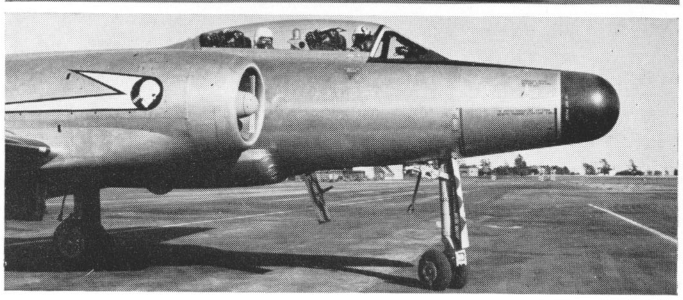


(Below) *A production CF–100 Mk.3.*



(Below) *CF–100 Mk.4s of 428 Sqdn. R.C.A.F. with modified canopy.*





Design of the CF–100 long-range all-weather fighter commenced in October 1946, to meet an R.C.A.F. requirement for a fighter possessing high speed and climb-rate coupled with good low-speed handling qualities to enable it to operate from small Arctic airfields. A further major requirement was exceptional endurance to enable the fighter to patrol effectively the vast uninhabited areas of Northern Canada, and this resulted in a relatively large and heavy machine with sufficient internal fuel tankage for a range of 2,500 miles. Detail design started in May 1947, and prototype tooling began in the following January.

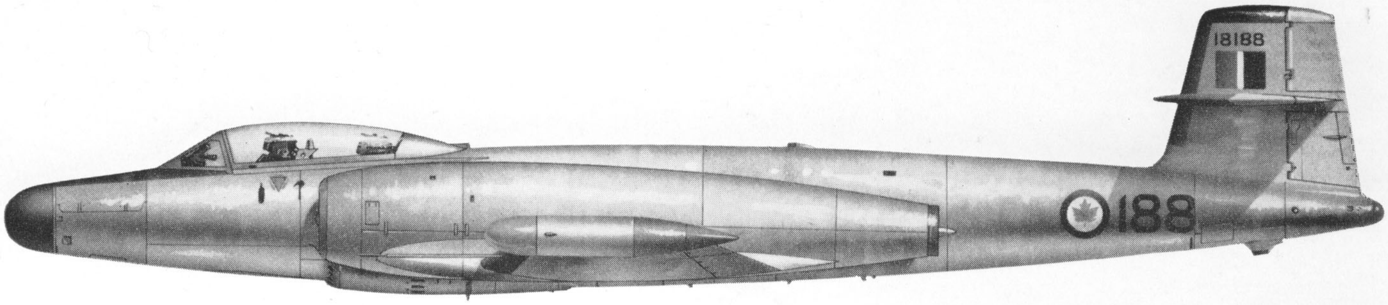
The CF–100 is a tandem two-seat, low-wing monoplane with a low aspect ratio, unswept wing, and two axial-flow turbojets attached to the fuselage sides. Thirty per cent of the total lift is derived from the centre section and engine nacelles. The two prototypes, designated CF–100 Mk.1, were powered by the 6,500 lb. thrust Rolls-Royce Avon R.A.3, as the Avro Orenda turbojet for which the CF–100 had been designed was not ready for installation. The first Avon-powered prototype flew on January 19, 1950, and the first of ten unarmed pre-production CF–100 Mk.2s for development flying and service evaluation, (one of which was completed as a Mk.2T dual-control conversion trainer) powered by the 6,000 lb. thrust Orenda Mk.2, was flown on June 20, 1951.

A contract for 124 CF–100 Mk.3 fighters had been placed in September 1950, and, basically similar to the pre-production Mk. 2, the first production aircraft was delivered in September 1952. The CF–100 Mk.3 was powered by two 6,000 lb. thrust Orenda Mk.8 engines which differed from the earlier Mk.2 in having modified compressors to improve acceleration characteristics. Armament comprised eight 0.5-in. guns in a ventral pack and APG 33 radar was enclosed in the pointed nose cone. Normal loaded weight was 34,000 lb. and maximum overload weight 39,750 lb. Maximum speed was 640 m.p.h., and initial climb rate exceeded 10,000 ft./min. Some CF–100 Mk.3s were completed as Mk.3T dual-control conversion trainers.

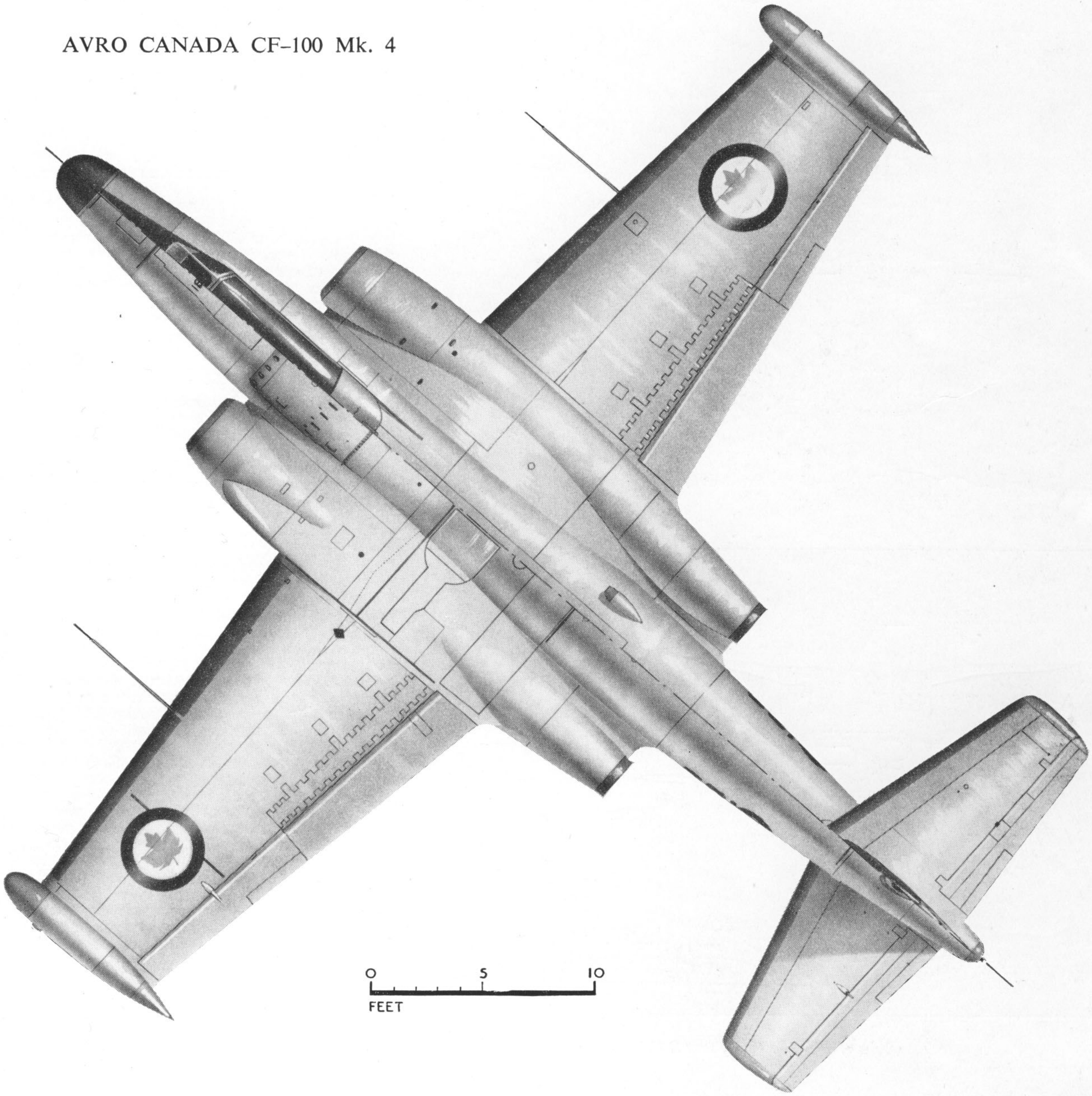
Contracts for the CF–100 Mk.3 were cut back to seventy machines, the last of which was delivered on July 11, 1953, the type being supplanted in production by the extensively modified CF–100 Mk.4, total orders for 600 of which are currently in process of completion. The CF–100 Mk.4 utilises only some 25% of the tooling of the Mk.3, and differs externally from the Mk.3 in having a lengthened, blunter nose housing APG 40 radar. This nose section is supplied as a unit by Hughes Aircraft and contains an automatic search and lock-on interceptor fire-control system which is used in conjunction with 2·75-in. Mighty Mouse unguided, folding-fin rockets, twenty-nine of which are carried in each of two wing-tip pods. The wing-tip containers (which increase span to 53 ft. 7 in.) possess fibreglass nose and tail-cones, the latter being jettisoned immediately the rockets are fired, the missiles breaking through the nose-cones. The containers can then be jettisoned, allowing a 20 deg./sec. increase in roll-rate. A further forty-eight 2·75-in. rockets can be carried in a ventral pack which can be substituted for packs containing either eight 0·5-in. guns or four 30-mm. guns. Alternatively, six Hughes F–98 Falcon self-homing missiles can be carried under each wing outboard section. A single-piece, free-blown cockpit canopy replaced the two-piece moulded-plastic canopy at an early stage in CF–100 Mk.4 production.

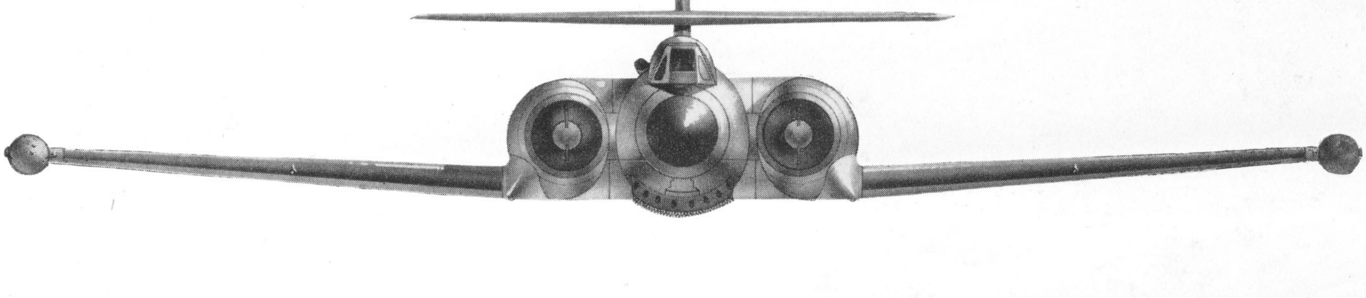
The prototype CF–100 Mk.4 flew on October 11, 1952, and the initial production Mk.4, which flew for the first time on October 24, 1953, was powered by two 6,500 lb. thrust Orenda Mk.9 turbojets, but later machines have the 7,000 lb. thrust Orenda Mk.11. The long-range characteristics resulting from the exceptional internal fuel capacity are indicated by a recent non-stop flight between Vancouver and North Bay, Ontario, the distance of 2,100 miles being covered in 3 hr. 50 min. at an average speed of 550 m.p.h. The CF–100 possesses the distinction of being the first aircraft with an unswept wing capable of exceeding Mach unity. Mach 1·0 was first exceeded in a dive on December 18, 1953.

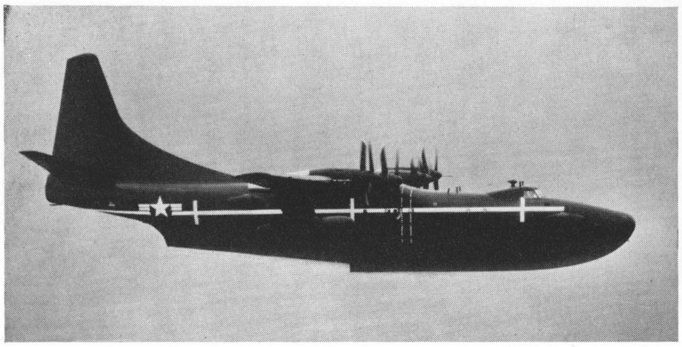
The CF–100 Mk.4 has a normal loaded weight in excess of 40,000 lb. and has a maximum speed of approximately 660 m.p.h. Overall dimensions are: span, 52 ft.; length, 54 ft. 2 in.; height, 15 ft. 6½ in.; wing area, 540 sq. ft. A projected swept-wing variant was designated the CF–103. The CF–133 was to have featured 25° sweep back at quarter-chord, and angular, swept tail surfaces. Development of the CF–103 was abandoned.

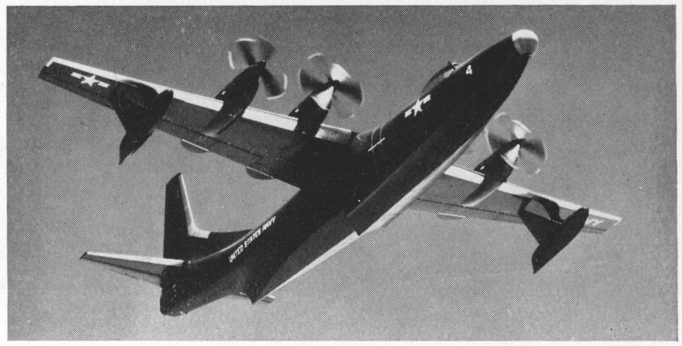


AVRO CANADA CF-100 Mk. 4

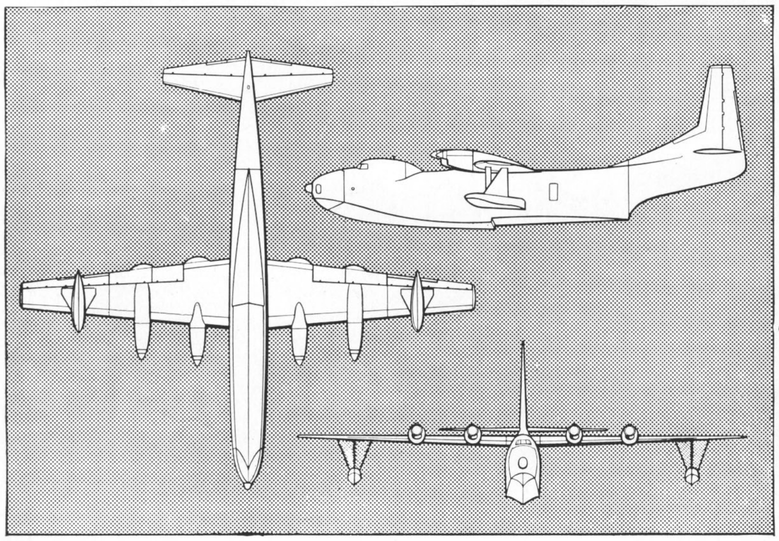








(Above, left) *The XP5Y–1 experimental reconnaissance flying boat,* (right) *the R3Y–1 Tradewind and* (drawing) *the R3Y–2.*

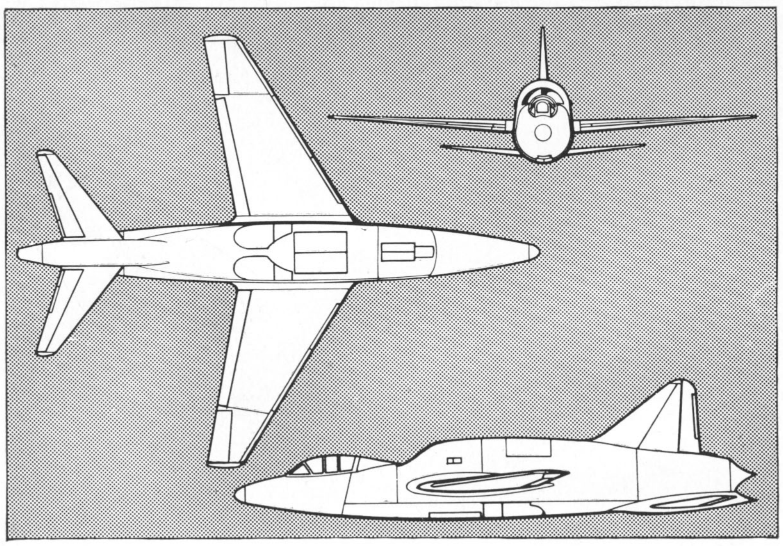


CONVAIR XP5Y–1 (R3Y) (APRIL) 1950

Originally developed to fulfil the long-range maritime reconnaissance role, the XP5Y-1 was noteworthy for its high-speed blended-hull design which, with its high length/beam ratio of 10, was intended to overcome the high aerodynamic drag associated with flying-boat hulls. The XP5Y-1 flew for the first time on April 18,1950, powered by four 5,500 e.h.p. Allison XT40-A-4 turboprops. In September 1950 the XP5Y-1 created a world's turboprop endurance record by remaining aloft for 8 hr. 6 min.

The XP5Y-1 possessed gun barbettes in the fuselage sides and weighed 160,000 lb. in maximum loaded condition. Top speed was 392 m.p.h. at 25,000 ft., and maximum range was 4,000 miles. However, changes in U.S. Navy requirements led to the redesign of the aircraft for the transport role and, as the R3Y Tradewind, twelve aircraft were ordered by the U.S. Navy.

The first Tradewind was launched on December 17, 1953, and differed from the XP5Y-1 in having 5,850 e.h.p. T40-A-10 units housed in new nacelles with shorter airscrew drive-shafts and tailpipes, and V-shaped float struts replacing the single struts. Initially the Tradewind possessed generally similar nose contours to those of the XP5Y-1 and was designated R3Y-1, but the R3Y-2 version, which flew on October 22, 1954, features bow loading-doors. The Tradewind has a maximum speed of 386 m.p.h. at 25,000 ft., and cruises at 300 m.p.h. Initial climb rate and range are 2,500 ft./min. and 4,500 miles respectively, and empty and loaded weights are 80,000 lb. and 150,000 lb. Overall dimensions are: span, 145 ft.; length (R3Y-1) 142 ft. 6 in.; height, 51 ft. 5 in.



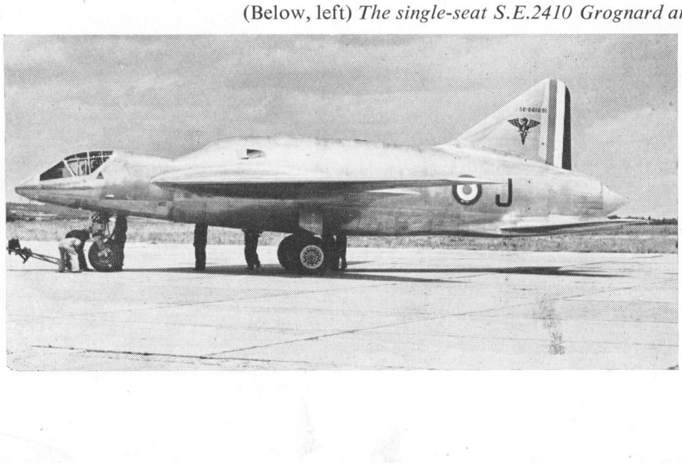
SUD-EST GOGNARD (APRIL) 1950

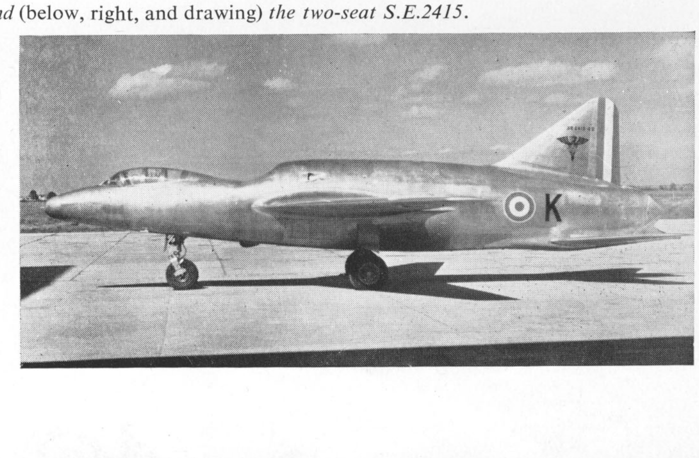
Originally designed as a single-seat ground attack aircraft, the Grognard embodied several novel features, not least of which was the method of engine installation. In order to provide undisturbed airflow over the wing surfaces a "buried" engine installation was chosen; and to provide sufficient power but avoid the considerable fuselage girth that would result from the side-by-side installation of two turbojets, the two 4,850 lb. thrust Hispano-Suiza Nene 101 turbojets were staggered one above the other in the rear fuselage.

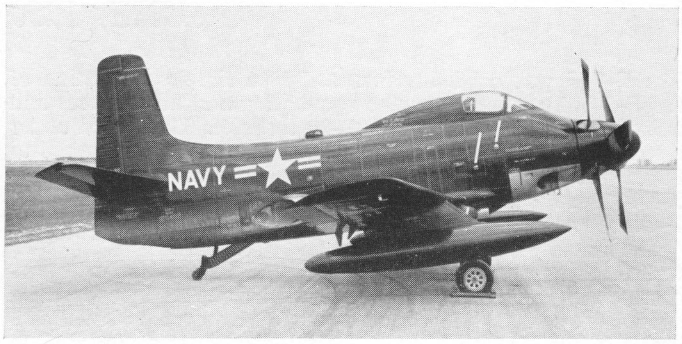
The first prototype Grognard, the S.E.2410, was a single-seat aircraft with 47° wing sweep, which flew for the first time on April 30, 1950. The second prototype, the S.E.2415, was a two-seater with a lengthened fuselage (from 50 ft. 6 in. to 55 ft. 2½ in.) and only 32° wing sweep (which increased span from 44 ft. 6½ in. to 51 ft. 1 in.), which first flew on February 14, 1951. Several developments of the Grognard were projected, including the S.E.2418, which was to have combined the sharp sweep of the first prototype with the long fuselage of the second and employ two 6,280 lb. thrust Tay 250 turbojets, and the S.E.2419 and S.E.2423, which were to have had the wing sweep of the second prototype.

The two Grognard prototypes were used as armament test-beds, conducting flight trials with such weapons as the 1,764-lb. Matra air-to-air missile, one of which could be carried beneath each wing halve. Maximum speed of the S.E.2410 (figures in parentheses refer to the S.E.2415) was 645 (596) m.p.h. at 4,920 ft., and initial climb rate was 5,315 ft./min. Empty and loaded weights were 24,508 (24,938) lb. and 31,967 lb.

(Below, left) *The single-seat S.E.2410 Grognard and* (below, right, and drawing) *the two-seat S.E.2415.*

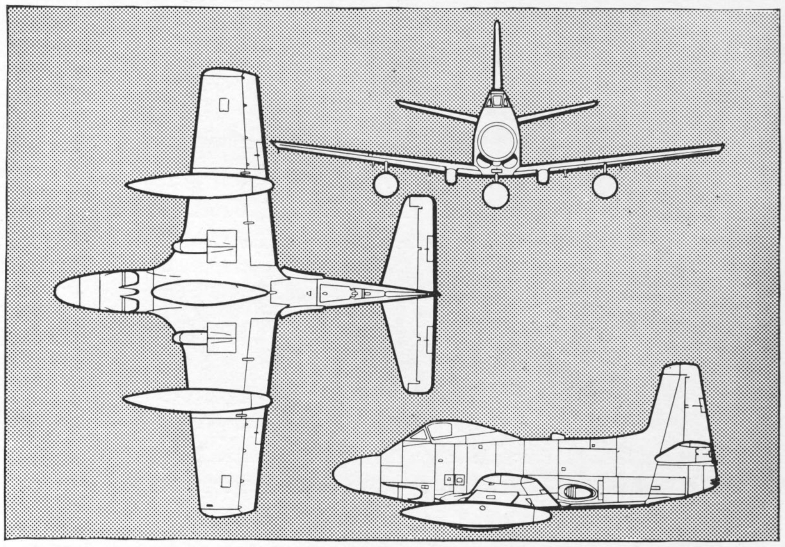






(Above, left, and three-view drawing) *The fourth production A2D–1 Skyshark* (*125482*) *and* (right) *the second XA2D–1* (*122989*).

DOUGLAS A2D–1 SKYSHARK (JUNE) 1950

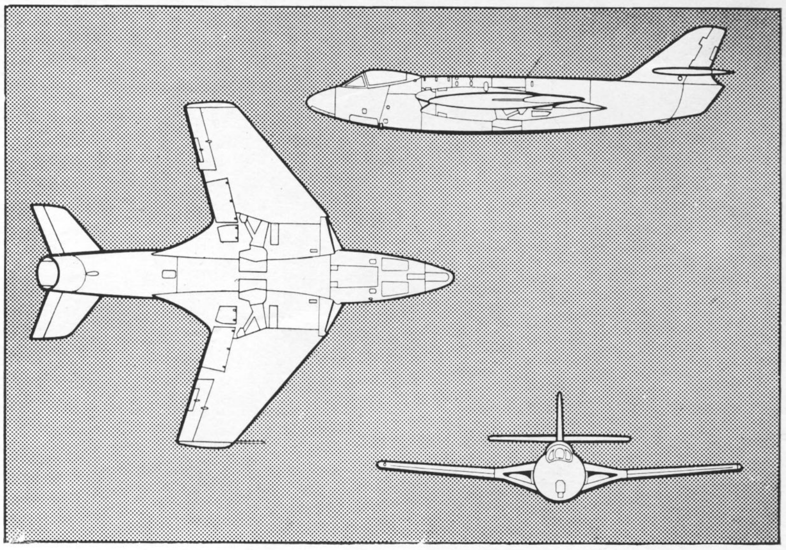


Designed originally for the U.S.Navy as a successor to the piston-engined AD Skyraider, the Skyshark shipboard attack aircraft flew for the first time on June 1, 1950. Its most interesting feature was its Allison XT40–A–6 twin turboprop engine which comprised two Allison T38 engines mounted side by side and driving co-axial contra-rotating airscrews through a common gearbox. One or other of the two engine components of the power plant could be shut down in order to protract endurance.

Two prototypes, designated XA2D–1, were built, and quantity production orders were placed for the Skyshark by the U.S. Navy. However, flight development with the XA2D–1s was continually delayed by power-plant failures, mostly associated with the gearbox and airscrew control, and orders for A2D–1 production were cut back to ten machines.

The production model Skyshark differs in detail from the XA2D–1, having a taller fin and rudder assembly, flush ends to the turbine exhaust pipes and a modified cockpit canopy. The XT40–A–6 twin turboprop develops 5,850 e.h.p. and provides the Skyshark with a maximum speed of 460 m.p.h. and a service ceiling of 40,000 ft. The A2D–1 was designed to carry an underwing load of bombs, rockets or fuel tanks of 8,000 lb., but a maximum underwing load of 15,000 lb. is permissible. Empty weight is 16,500 lb., and maximum loaded weight exceeds 30,000 lb. Dimensions are: span, 50 ft.; length, 38 ft. 3¾ in.; height, 15 ft. 10 in.

HAWKER P.1081 (JUNE) 1950

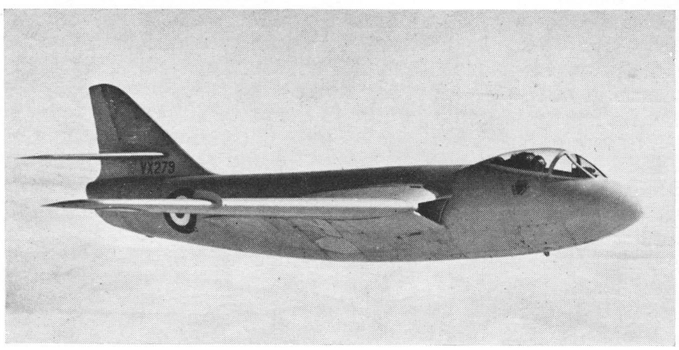


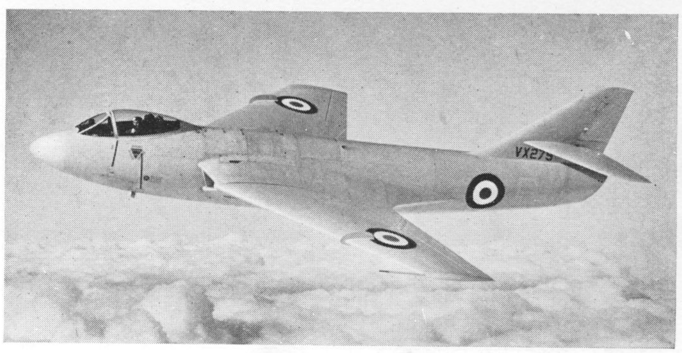
The P.1081 was a progressive development of the Hawker P.1052, differing from its predecessor in two major external aspects; a single jet pipe for the 5,000 lb. thrust Rolls-Royce Nene 4 turbojet replaced the bifurcated trunk of the P.1052, and all tail surfaces were swept to permit flight at higher Mach numbers.

The P.1081 was a private-venture single-seat fighter and, in fact, commenced life as the second prototype P.1052. The P.1081 was flown for the first time on June 19, 1950, only fourteen weeks after the drawings had been completed and five weeks after the P.1052 had been returned for conversion. The P.1081 retained the front fuselage, 35° swept wing, and undercarriage of the P.1052, and to make provision for the ultimate installation of afterburning equipment these components were married to a deepened rear fuselage housing a straight-through jet pipe. Provision was made for the installation of a fixed armament of four 20-mm. guns in the forward fuselage and jettisonable fuel tanks could be carried underwing.

It was originally proposed that production of the P.1081 should be undertaken in Australia for the R.A.A.F., but this plan was not proceeded with, and no further machines were built after the first prototype was destroyed in an accident on April 3, 1951. The P.1081 was used to extend the flight programme initiated with the P.1052 into the Mach 0·9–0·95 range, and much of the experience gained with this aircraft was later incorporated in the P.1067 Hunter. The overall dimensions of the P.1081 were: span, 31 ft. 6 in.; length, 37 ft. 3½ in.; height, 10 ft. 10 ins.; wing area, 258 sq. ft.

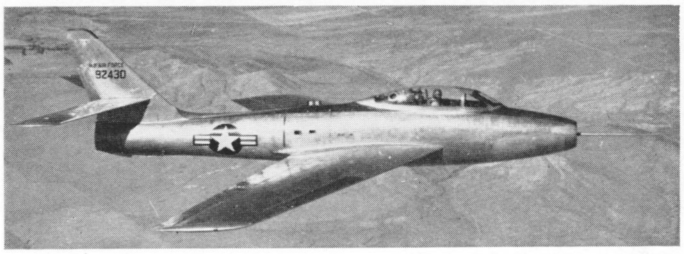
The sole prototype Hawker P.1081 (*VX279*) *which commenced life as the second P.1052* (see page 90).



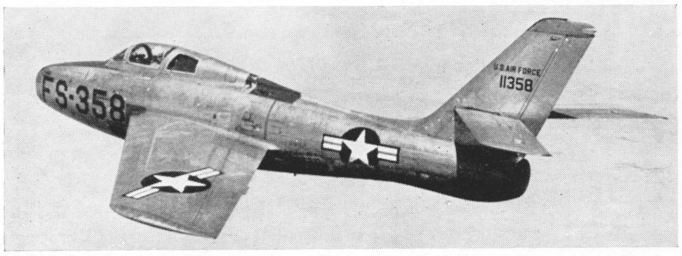


REPUBLIC F-84F THUNDERSTREAK

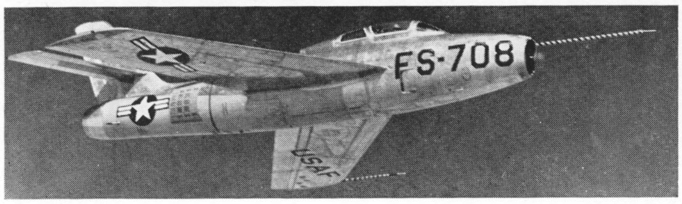
(JUNE) 1950



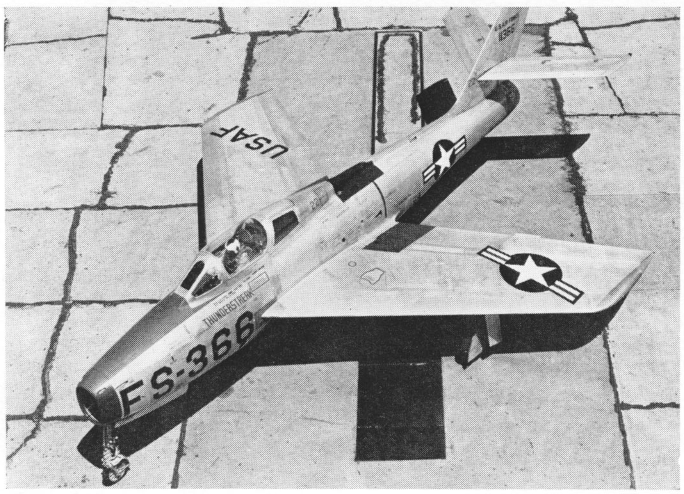
(Above) *The XF–84F (49–2430) powered by an Allison J35–A–25 turbojet.*



(Above) *A production F–84F Thunderstreak fighter-bomber (51–1358).*



(Above) *The YF–84J (51–1708) powered by a General Electric J73 turbojet.*



(Above) *F–84F–5–RE Thunderstreak.* (Below) *RF–84F–1–RE Thunderflash.*

The F–84F was originally intended as a simple adaptation of the F–84E Thunderjet to take swept wing and tail surfaces and a 5,800 lb. thrust Allison J35–A–29 turbojet. Developed under a stringent government economy programme, it was planned to utilize nearly 60 per cent of the tooling used for the earlier F–84E, and the first prototype, the XF–84F, employed a standard F–84E fuselage and, in this form, flew on June 3, 1950.

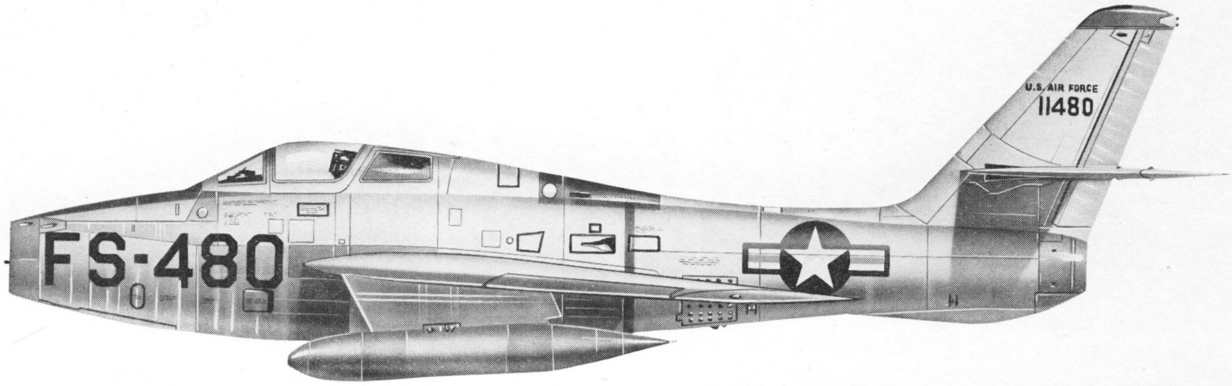
The first XF–84F, powered by a 5,200 lb. s.t. Allison J35–A–25 turbojet, was completed in 167 days and differed from its predecessor in having new wing and tail assemblies incorporating sweepback of 40° at 25 per cent chord. However, with the outbreak of the Korean War, additional funds were allocated to F–84F development and it was decided to adapt the design for the installation of the more powerful Wright J65 (licence-built Armstrong Siddeley Sapphire) engine. The greater airflow demanded by the J65 necessitated a 7-in. increase in fuselage depth, and a second XF–84F, powered by a Wright YJ65–W–1 (assembled largely from components imported from Britain), flew on February 14, 1951. This machine was virtually a new aeroplane and few components were interchangeable with those of the F–84E Thunderjet. The oval-section fuselage was deeper than that of the earlier machine and the new wing incorporated a high proportion of press forgings in its structure, replacing the built-up components of the F–84E wing. A new cockpit canopy was adopted which hinged upwards on parallel links, perforated air brakes were hinged to the fuselage sides, and a single-piece "all-flying" tail surface (installed between the 250th and 300th production machines) eventually replaced the original combination of elevator and variable-incidence tailplane.

The first production F–84F Thunderstreak, also powered by the YJ65–W–1, flew on November 22, 1952. Initial production Thunderstreaks were powered by the J65–W–1 turbojet rated at 7,220 lb. thrust, but the F–84F–5–RE production batch and subsequent aircraft have the slightly modified J65–W–3.

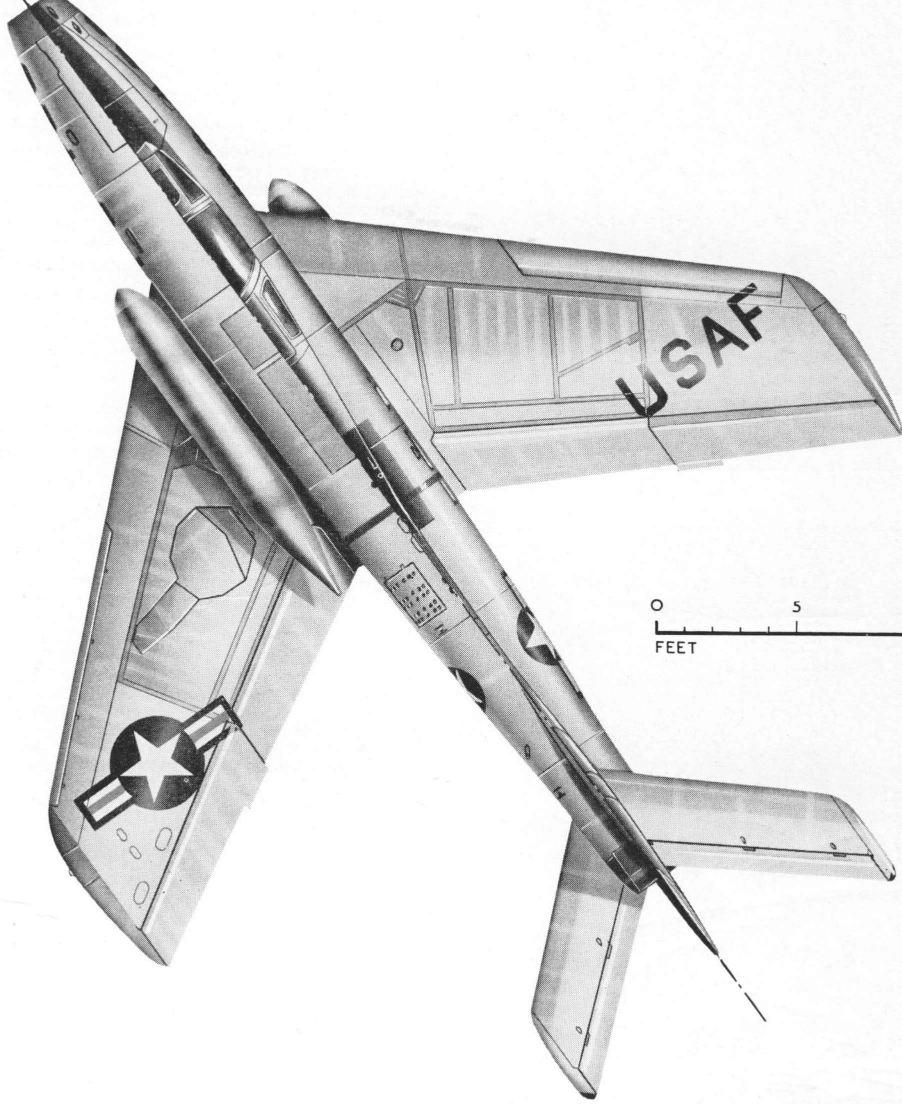
The F–84F has an airframe limiting Mach Number of 1·175 and an approximate maximum speed of 720 m.p.h. at sea level. With external loads, limiting speeds vary between Mach 0·9 and 0·94. Service ceiling is 48,000 ft. and initial climb rate is 7,500 ft./min. Normal combat radius is 850 miles, and maximum range (with 475 Imp. gall. internally, two 375 Imp. gall. and two 191 Imp. gall. external tanks) exceeds 2,500 miles. Fixed armament comprises six 0.5-in. M–3 guns. Without external stores the F–84F has a loaded weight of 19,340 lb. which is increased to 26,030 lb. with an external load of two 191 gall. fuel tanks, two 1,000-lb. bombs, eight HVAR and rocket-assisted take-off gear. Maximum permissible weight is 28,000 lb., including an underwing load of 6,000 lb. It is proposed to instal a liquid-fuel rocket motor under the tail to provide 5,000 lb. thrust to assist take-off with heavy loads and replace the four RATO bottles, providing 4,000 lb. thrust for 13 sec., currently used. Overall dimensions are: Span, 33 ft. 7¼ in.; length, 43 ft. 4¾ in.; height, 14 ft. 4¾ in.

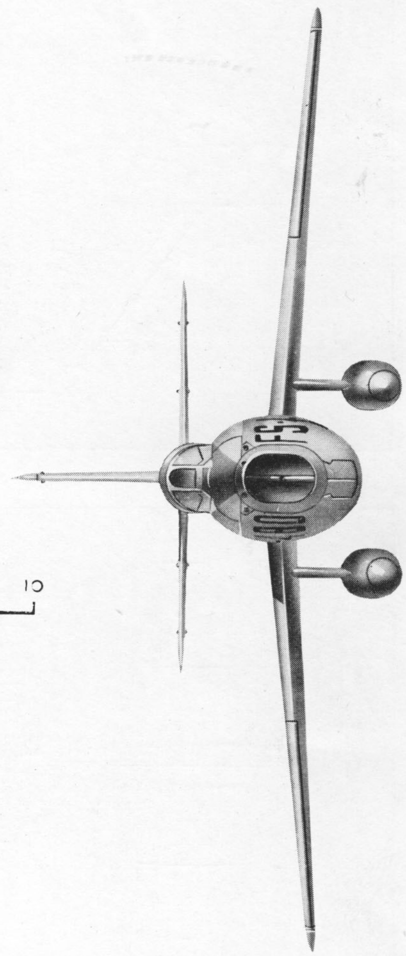
The second XF–84F was modified late in 1951 by replacing the nose air intake with twin wing root intakes. This arrangement has not been adopted for the F–84F but has been incorporated in a photo-reconnaissance fighter variant, the RF–84F Thunderflash, developed concurrently with the fighter-bomber. The wing root air intakes permit the installation of a camera bay in the nose which can accommodate several combinations of remotely-controlled and automatic vertical and oblique cameras. The prototype RF–84F Thunderflash flew in February 1952, and first deliveries to the U.S.A.F. were made in March 1954. Apart from the wing root intakes, the RF–84F differs from the F–84F externally in having a lengthened nose (increasing fuselage length to 47 ft. 7¾ in.) and taller fin and rudder assembly (increasing height to 15 ft.). Performance is slightly higher than that of the F–84F owing to the improved fineness ratio of the fuselage, and armament comprises four 0.5-in. M–3 guns.

A modified version of the RF–84F is to be employed by the FICON (contraction of "FIghter" and "ReCONnaissance") project whereby the reconnaissance fighter will be carried in the bomb-bay of the Convair GRB–36J reconnaissance-bomber and launched in the vicinity of the target, being retrieved after the mission has been completed. An experimental variant of the Thunderstreak is the YF–84J powered by a 9,000 (approx.) lb. thrust General Electric J73–GE–3 turbojet. The first of two YF–84Js for the U.S.A.F. flew on May 7, 1954.

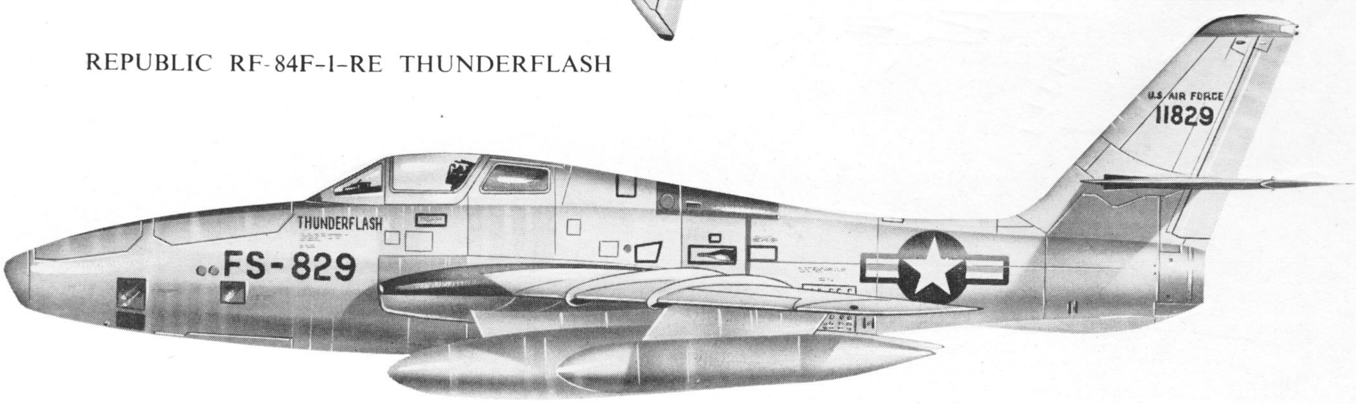


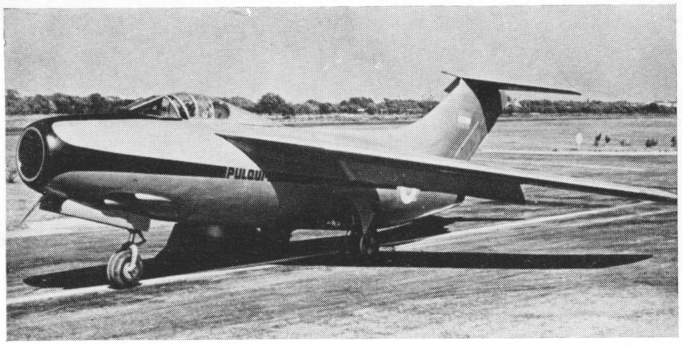
REPUBLIC F-84F-5-RE THUNDERSTREAK

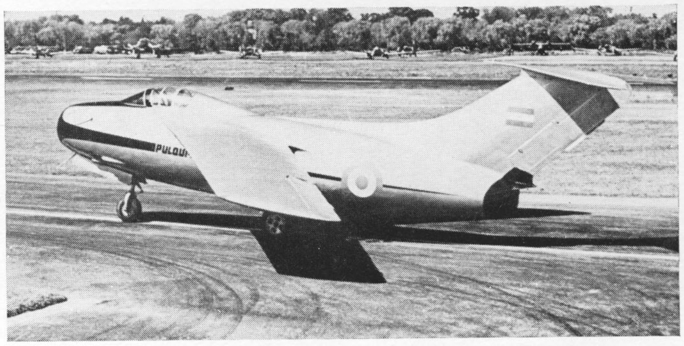




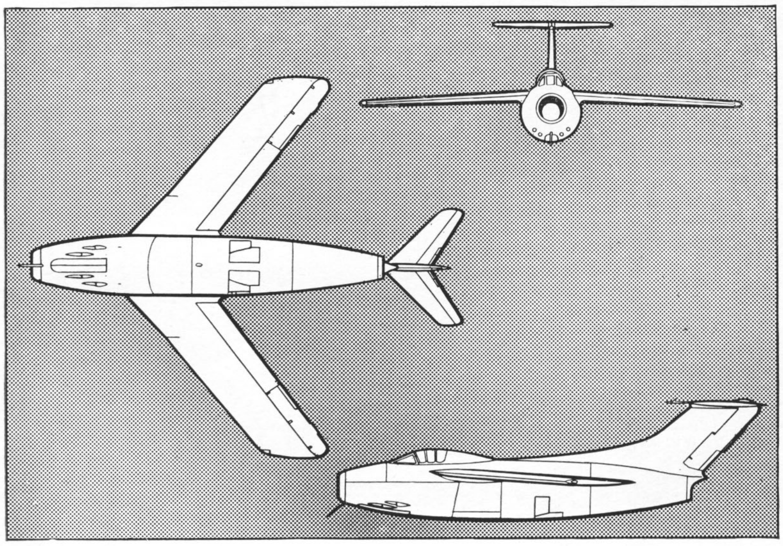
REPUBLIC RF-84F-1-RE THUNDERFLASH







The first prototype Pulqúi II single-seat fighter designed by Kurt Tank.

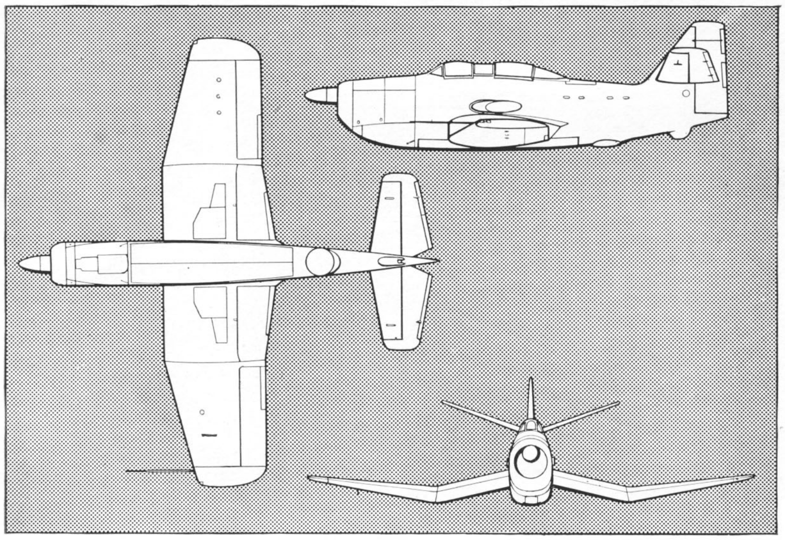


I.A.M.E. 33 PULQÚI II (JUNE) 1950

The Pulqúi (Arrow) II was designed by Prof. Dipl. Ing. Kurt Tank, former technical director of the German Focke-Wulf company, and several prototypes were built by the Industrias Aeronauticas y Meccanicas del Estado at Cordoba, Argentina. The Pulqúi II embodied much of the experience gained by the German aircraft industry during the war years, and its design was correspondingly advanced. Several of its design features characterised late wartime German jet-fighter projects, such as the Focke-Wulf Ta 183.

The first prototype Pulqúi II flew on June 27, 1950, powered by a 4,565 lb. thrust Rolls-Royce Nene 2 turbojet installed aft of the pilot's cockpit in a comparatively short fuselage cut back under the tail assembly. The shoulder-positioned wing was swept back 40°, and the fin and rudder were swept 50° in order to place the control surfaces sufficiently aft of the c.g. for satisfactory balance. The tailplane was mounted at the extreme tip of the verticle surfaces to avoid the turbulent wake of the high-mounted wing.

The prototype Pulqúi had a maximum speed of 646 m.p.h. at 16,400 ft. and an initial climb rate of 5,870 ft./min. Ceiling was 49,530 ft., and empty and loaded weights were 7,920 lb. and 12,210 lb. respectively. Overall dimensions were: span, 34 ft. 9 in.; length, 38 ft.; height, 10 ft. 10 in.; wing area, 270 sq. ft.; and armament included four 20-mm. cannon. Two prototypes were destroyed during flight testing, and the proposed production version was to have a high-powered, afterburning axial-flow turbojet with which level speeds in the vicinity of Mach 0·98 were expected.



BLACKBURN Y.B.1 (JULY) 1950

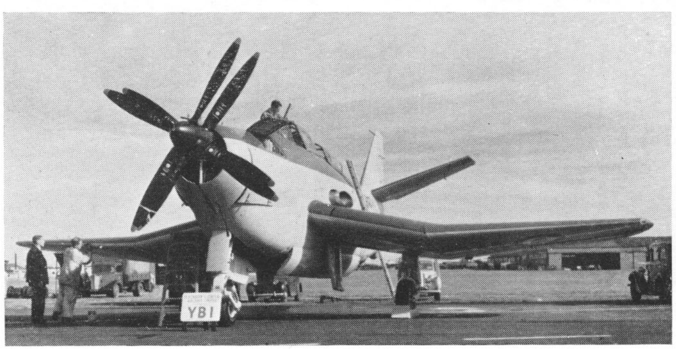
The Y.B.1, designed to meet the same requirements as those fulfilled by the Fairey Gannet, flew for the first time on July 19, 1950, powered by an Armstrong Siddeley Double Mamba A.S.M.D.1 developing 2,640 s.h.p. plus 810 lb. residual thrust (2,950 e.h.p.). Either one of the two engine components of the Double Mamba coupled turboprop could be stopped in flight, enabling the Y.B.1 to cruise on one component.

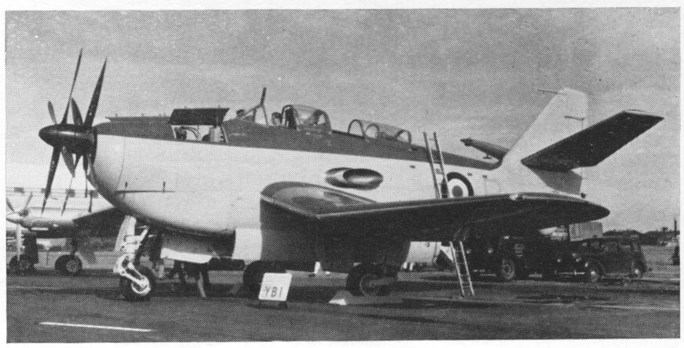
In its original form the design was designated Y.A.5, and it was proposed to employ a Napier Coupled Naiad N.Na.C.1 turboprop, but the discontinuation of development of this engine led to the change to the Double Mamba. Prior to the flight trials of the Y.B.1, considerable experience with the airframe was obtained with two Rolls-Royce Griffon piston-engined prototypes designated Y.A.7 and Y.A.8 respectively. Apart from its power plant, the Y.B.1 was generally similar to the Y.A.8 and made its first deck-landing on H.M.S. *Illustrious* on October 30, 1950.

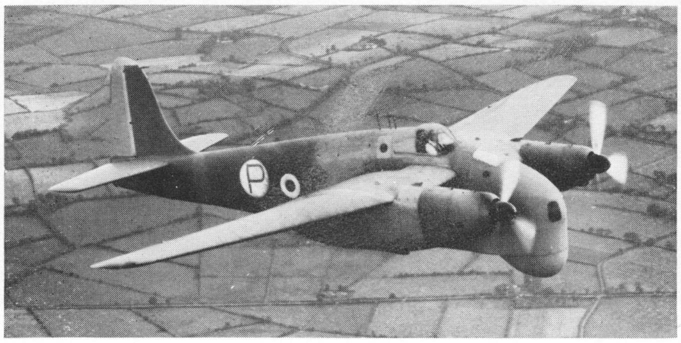
The Y.B.1 carried a crew of three and a variety of warloads in a fuselage bomb-bay. Aft of the bomb-bay a "dustbin" type radome could be lowered to provide 360° scan in azimuth. The gull-type low wing was power-folded, each centre section having a double fold, the main panels folding upwards and the tips downward. No production orders were placed for the Y.B.1.

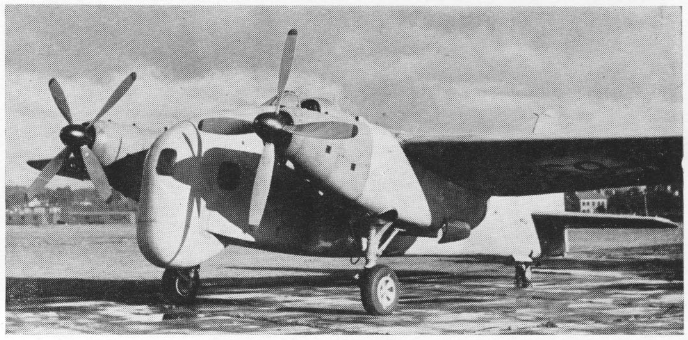
Overall dimensions were: span, 44 ft. 2 in.; length, 42 ft. 5 in.; height, 16 ft. 9 in.; width folded, 19 ft. 6 in. The Y.B.1 attained a maximum speed in the vicinity of 300 m.p.h., and endurance exceeded 3 hrs. Loaded weight was some 18,000 lb.

The Blackburn Y.B.1 was designed to fulfil the same requirements as those met by the Fairey Gannet.



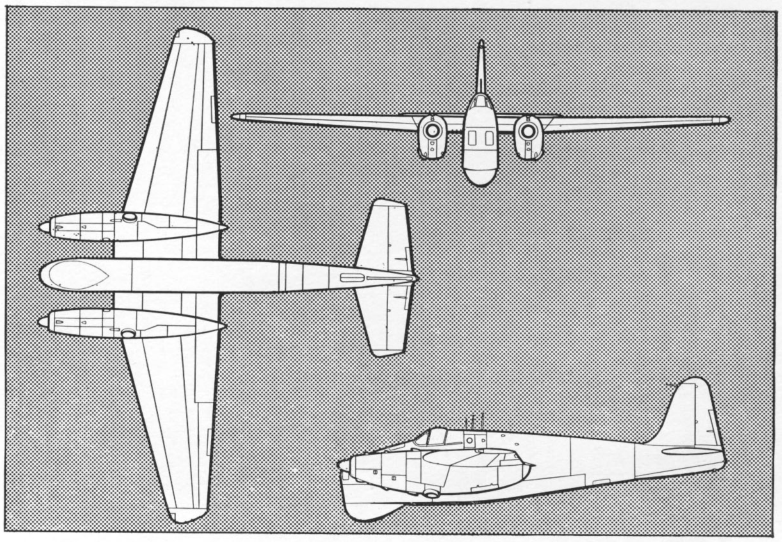






The Short S.B.3 experimental anti-submarine aircraft was derived from the piston-engined Sturgeon.

SHORT S.B.3 (AUGUST) 1950



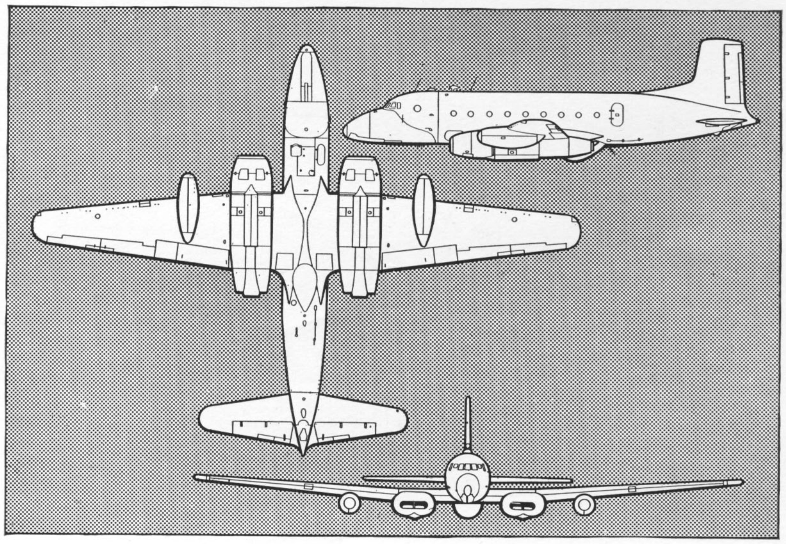
Derived from the piston-engined Sturgeon naval target-tug, the S.B.3 experimental shipboard anti-submarine and search aircraft flew for the first time on August 12, 1950, powered by two 1,475 s.h.p. Armstrong Siddeley Mamba A.S.Ma.3 turboprops.

The S.B.3 retained the wing and tail assemblies of the Sturgeon, but the fuselage was extensively redesigned and the nose was completely revised, with several observation windows for the radar operator. A pendulous search-radar housing was attached under the extreme nose, and four depth charges could be carried in an internal bay. Additional ordnance loads could be carried under the wing outboard of the engine nacelles. A crew of three was carried.

The wing was of all-metal two-spar construction, and for carrier stowage the outer sections folded rearwards hydraulically about the rear spar to lie alongside the fuselage, with the leading edges downwards. Overall dimensions were: span, 59 ft. 9 in.; length, 45 ft.; height, 13 ft. 2½ in.; width folded, 22 ft. 5 in.; gross wing area, 560·4 sq. ft.

No details of the performance of the S.B.3 are available for publication, but it is known that this experimental anti-submarine aircraft was designed to cruise at comparatively low speeds, with a patrol duration in excess of three hours. In comparison with the contemporary Blackburn Y.B.1 and Fairey Gannet anti-submarine aircraft which employed the Double Mamba coupled-turboprop unit, the S.B.3 could not cruise on the power of one engine without considerable assymetric forces being exerted.

AVRO ASHTON (SEPTEMBER) 1950

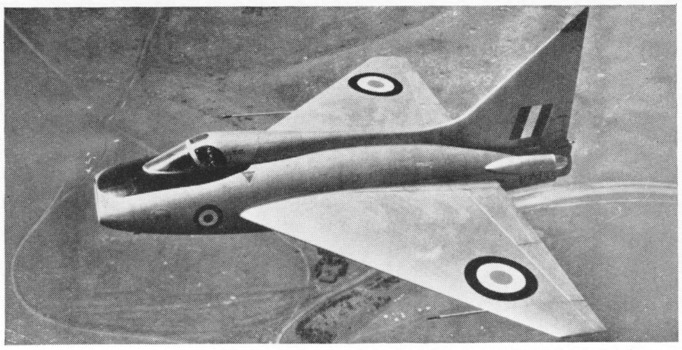


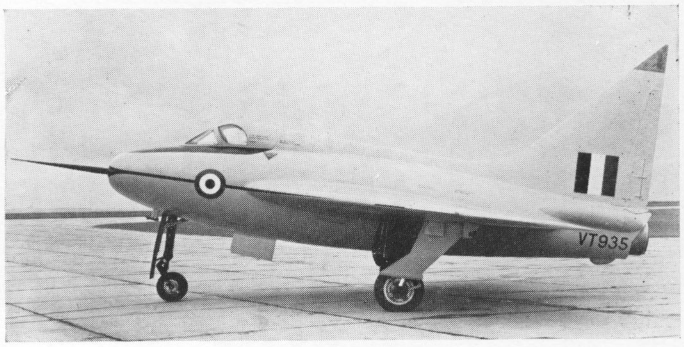
One of the very few large jet aircraft built purely for the research role, the Type 711 Ashton was adapted from the piston-engined Tudor 2 airframe for use as a flying test-bed by means of which various problems associated with the high-altitude operation of jet aircraft could be investigated. Intended for continuous operation at altitudes in the vicinity of 40,000 ft., six Ashtons were built to the order of the Ministry of Supply, the first flying on September 1, 1950.

Powered by four 5,000 lb. thrust Rolls-Royce Nene 5 and 6 turbojets installed in two paired nacelles, the first Ashton was a Mk. 1 intended to collect data on the actual operation of turbojets at high altitudes. The second aircraft, the Ashton Mk.2, was primarily intended for high-altitude air-conditioning tests, and the third, the Ashton Mk 3, with ventral radome and bomb containers outboard of the engine nacelles, was used in the development of advanced bomb-sight apparatus. Two further Mk. 3s and one Mk. 4 were built, being used for a variety of engine and instrument development tests, and one Ashton is employed as a test-bed for the afterburning Bristol Olympus turbojet, one engine of this type being mounted in a pod under each wing.

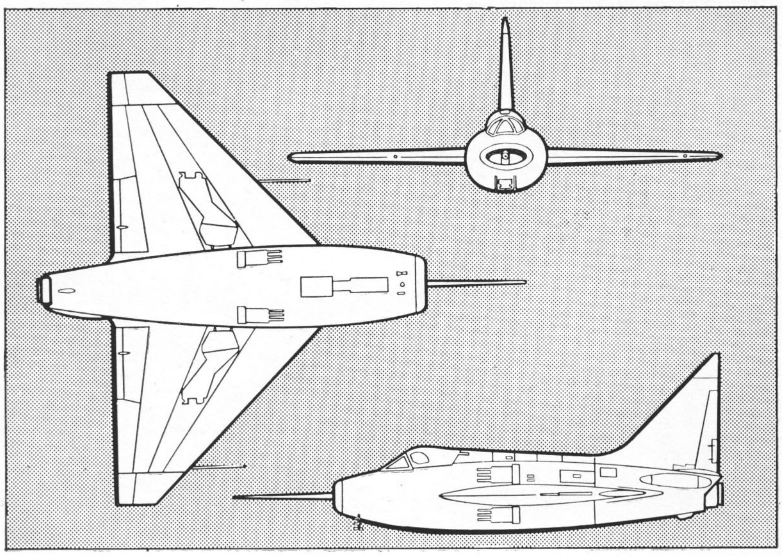
The Ashton normally carries a crew of five and has the following overall dimensions: span, 120 ft.; length, 89 ft. 6½ in.; height, 31 ft. 3 in.; wing area, 1,421 sq. ft. With sufficient fuel for 2 hr. 15 min. operation at 40,000 ft., the Ashton Mk.1 has a take-off weight of 72,000 lb. at which maximum speed is 439 m.p.h. at 35,000 ft. Cruising speed is 406 m.p.h. at 35,000 ft., and maximum climb rate is 2,900 ft./min. Range is 1,725 miles.

(Below, left) *The fourth Ashton research aircraft* (*WB493*) *and* (right) *the third Ashton* (*WB492*).





(Above, left) *Boulton Paul P.111 (VT935) and* (above, right and g.a. drawing) *after modification as the P.111A.*



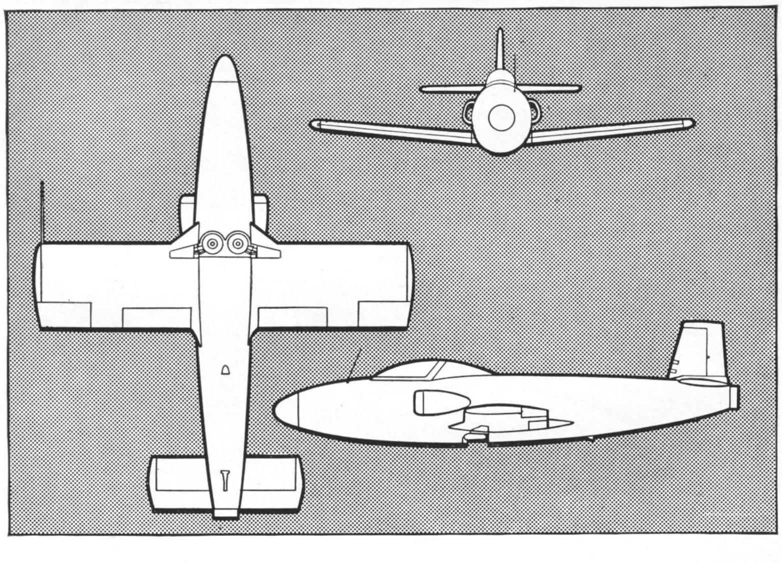
BOULTON PAUL P.111 (OCTOBER) 1950

Built to investigate the delta wing at transonic speeds, the P.111 research aircraft flew for the first time on October 6, 1950. Powered by a single Rolls-Royce Nene turbojet, aspirated through a broad intake duct of oval form in the nose, the P.111 featured a wing of delta planform with a sweep of 45° on the leading edge and an exceptionally low thickness/chord ratio. An unusual feature of the wing was provision of detachable wing-tips which enabled comparative tests to be made with blunt and pointed configurations. The tip of the vertical fin could also be detached. Control was effected through elevons on the wing and a rudder.

With approximate empty and loaded weights of 6,500 lb. and 9,600 lb. respectively, the overall dimensions of the P.111 with wing- and fin-tips fitted were: span, 33 ft. 6 in.; length, 26 ft. 1 in.; height, 12 ft. 6½ in.; wing area, 200 sq. ft.

During 1953 the P.111 airframe was modified internally and fitted with four rectangular air brakes disposed at equal intervals around the fuselage aft of the pilot's cockpit. A nose probe containing a pressure head was fitted, and the aircraft was redesignated P.111A. Despite the relatively low power of the Nene turbojet (5,100 lb. thrust), the P.111A is capable of attaining level speeds in the Mach 0·95–0·98 range and can exceed Mach unity in a shallow dive. As the P.111A, the aircraft recommenced its flight-test programme on July 2, 1953.

It can be assumed that the data accumulated from the high-speed research programme undertaken with the P.111/P.111A delta aircraft will be incorporated in more advanced supersonic aircraft of delta planform.



D.A.P. (A93) PIKA (OCTOBER) 1950

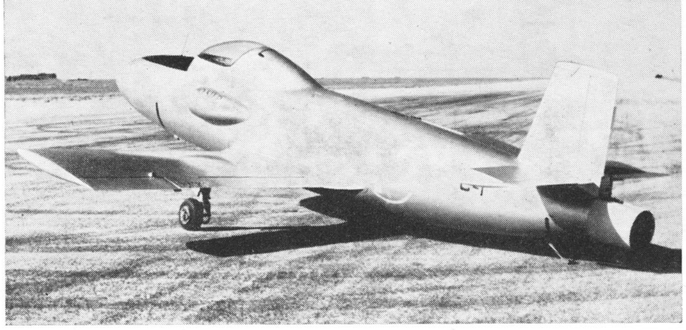
The Pika (an aboriginal word meaning "flier") was the first jet-propelled aircraft to be designed and built in Australia, and was developed by the Division of Aircraft Production. The Pika resulted from a British Ministry of Supply specification E.7/48 calling for a high-speed pilotless target aircraft for use in the guided-missile development programme and the decision to develop a piloted version concurrently with the pilotless model.

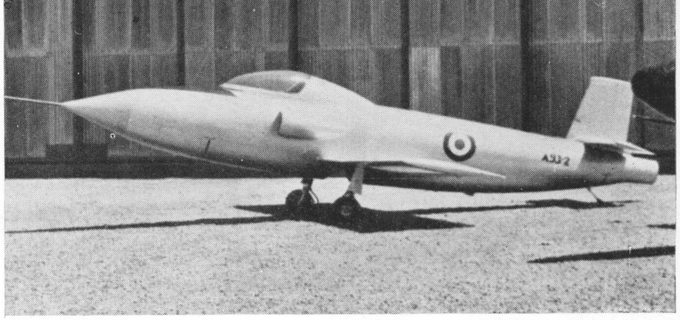
The Pika was flown for the first time late in October 1950 and differed little from the pilotless model, designated Jindivik Mk.1, apart from the provision of a pilot's cockpit with the necessary controls and instruments, fuselage-side air intakes (in place of the submerged entry in the top of the fuselage of the Jindivik), and the provision of a retractable undercarriage —a jettisonable take-off trolley and a fixed skid being used by the pilotless version.

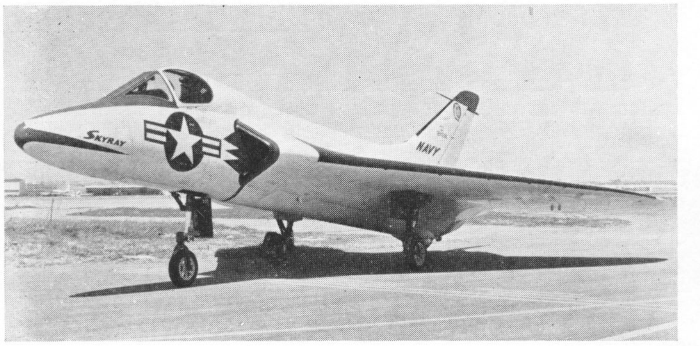
Like the Jindivik Mk.1, the Pika was powered by a 1,050 lb. thrust Armstrong Siddeley Adder A.S.A.1 turbojet, and its overall dimensions included a span of 19 ft. and a length of 23 ft. 3¾ in. Two Pikas were built for use in the Jindivik development programme, being intended to check the general characteristics of the design, prove the components of the remote-control system employed by the Jindivik, and develop new equipment.

Twelve Jindivik Mk.1 pilotless aircraft were built, and fifty Jindivik Mk.2s are currently under construction. These differ from the earlier mark and the Pika in having a thinner wing and a 1,900 lb. thrust Armstrong Siddeley Viper A.S.V.6.

(Below, left and g.a. drawing) *The first Pika (A93–1) and* (right) *the second Pika (A93–2).*

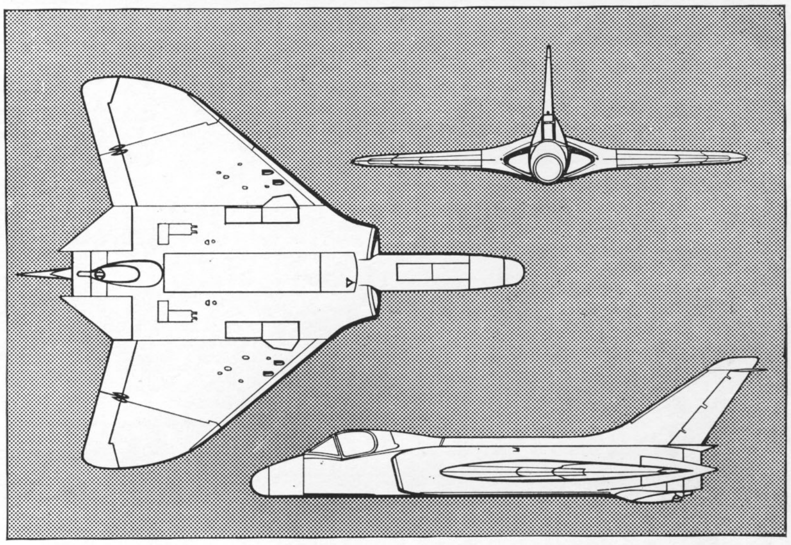






(Above, left) *The first XF4D–1 Skyray prototype* (*124586*) *and* (right) *the first production F4D–1* (*130740*).

DOUGLAS F4D–1 SKYRAY (JANUARY) 1951

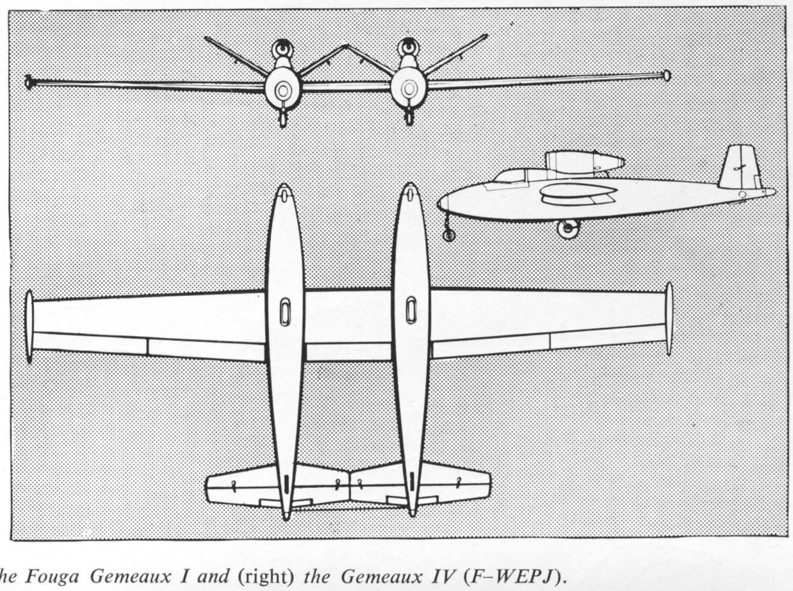


Design of the Skyray was initiated in 1945, and the first of two Skyray prototypes, the XF4D-1, flew on January 23, 1951, powered by a 5,000 lb. thrust Allison J35-A-17 turbojet. Its wing, the outer panels of which folded upwards for carrier stowage, was not of true delta planform, the wing-tips being curved and the trailing edges swept. Both nose- and tail-wheel were necessary because of the high approach angle of the wing.

The J35-A-17 was replaced by the Westinghouse XJ40-WE-6 of 7,000 lb. thrust for further trials, and this unit was in turn succeeded by the afterburning XJ40-WE-8, which provided a total thrust of 11,600 lb. With this turbojet the second XF4D-1 established a World Air Speed Record of 752·9 m.p.h. on October 3, 1953. The production F4D-1 was to have been powered by the J40-WE-10 turbojet, but the discontinuation of development of this unit resulted in a switch to the Pratt and Whitney J57-P-2 of 9,700 lb. thrust and 14,500 lb. thrust with afterburning. With this power plant, the first production F4D-1 exceeded Mach 1·0 in level flight while being delivered to the U.S. Navy on June 5, 1954.

The F4D-1 weighs 20,000 lb. loaded. Armament comprises four 20-mm. cannon, and this can be augmented by six under-wing pods each containing seven 2·75-in. folding-fin rockets, four pods each containing nineteen rockets, or two 2,000-lb. bombs. The internal fuel tankage of some 625 Imp. gal., which provides an endurance of approximately 45 min., can be augmented by two 125 or 250 Imp. gal. jettisonable tanks. Initial climb rate exceeds 15,000 ft./min., and dimensions are: span, 33 ft. 6 in.; length, 42 ft.; height, 12 ft. 10 in.

FOUGA GEMEAUX (MARCH) 1951



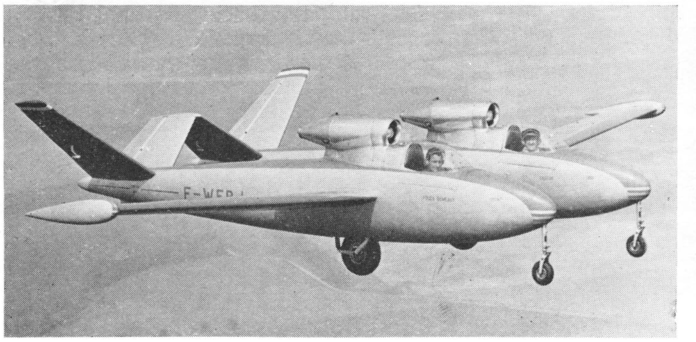
Developed for use as a flying test-bed for the Turboméca range of light turbojets, the C.M.88-R Gemeaux comprised two C.M.8.R-9.8 Cyclope fuselages, and two Cyclope outer-wing panels and tail units, the fuselages being joined by a parallel-chord centre wing and a horizontal strut aft below the tail surfaces.

Two Gemeaux airframes were built, each being flown with several types of turbojet. The Gemeaux was first flown on March 6, 1951, with two 220 lb. thrust Piméné turbojets, one mounted on each fuselage. In this form the test-bed was known as the Gemeaux I. The Gemeaux II flew on June 16, 1951, powered by a 605 lb. thrust Marboré I mounted on the centre wing midway between the fuselages. Redesignated Gemeaux III, the prototype Marboré II (initially developing 770 lb. thrust) was installed, and flown on August 24, 1951, and with 880 lb. thrust production Marboré II on January 2, 1952.

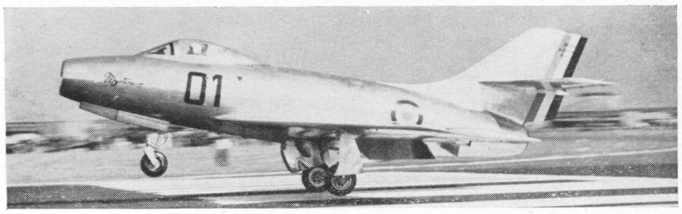
As the Gemeaux IV, the airframe was used as a test-bed for the Turboméca Aspin I ducted-fan turbojet of 440 lb. thrust, with which it flew on January 2, 1952, and as the Gemeaux V with the 790 lb. thrust Aspin II on June 21, 1952.

The Gemeaux had a wing span of 35 ft. 4 in., a length of 21 ft. 10 in., and a height of 6 ft. 4 in. Weights and performances varied with the type of turbojet installed, loaded weight ranging from the 2,411 lb. of the Gemeaux I to the 2,719 lb. of the Gemeaux V, and maximum speed at sea level ranging from 155 m.p.h. for the Gemeaux IV to the 248 m.p.h. of the Gemeaux III. The Gemeaux carried five fuel tanks with a total capacity of 48·4 Imp. gal.

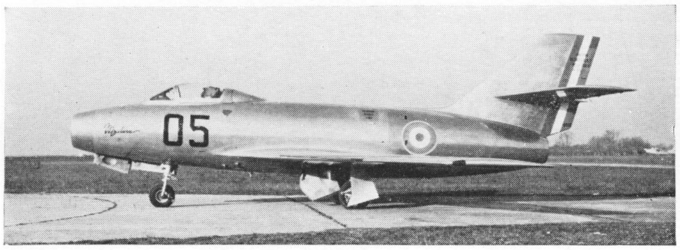
(Below, left and three-view drawin g) *The Fouga Gemeaux I and* (right) *the Gemeaux IV* (*F–WEPJ*).



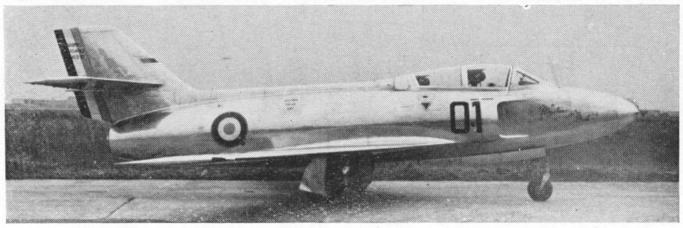
DASSAULT MYSTÈRE (FEBRUARY) 1951



(Above) *The Nene-powered first prototype Mystère.*

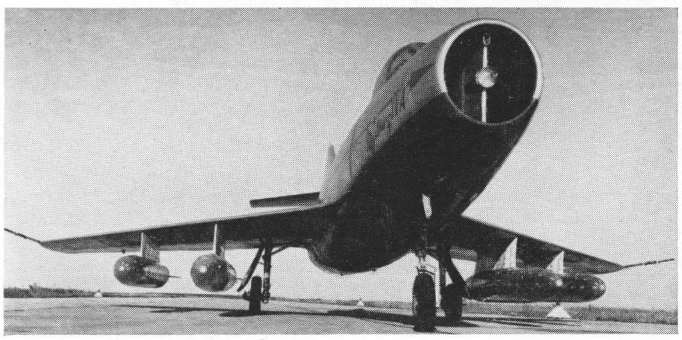


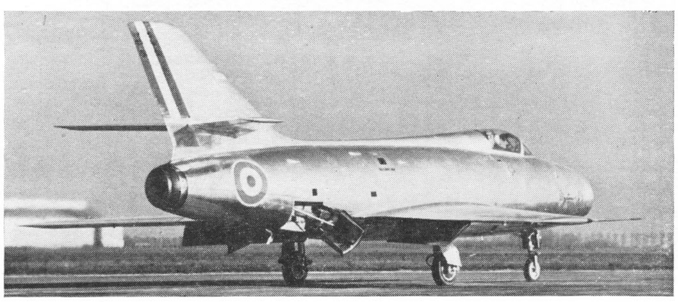
(Above) *The Tay-powered Mystère IIA.*



(Above) *The two-seat Mystère III nightfighter.*


(Above) *The Tay-powered Mystère IV prototype.*


(Above) *A pre-production Mystère IVA.* (Below) *The Mystère IVB.*



The initial version of the Dassault M.D.452 Mystère single-seat fighter was virtually a progressive development of the M.D.450 Ouragan, embodying a 30° swept wing but retaining the fuselage and 5,070 lb. thrust Hispano-Suiza Nene 104B turbojet of the earlier fighter. In this form the first prototype, or Mystère I, flew on February 23, 1951.

The second and third prototypes were flown on April 5 and July 2, 1952, respectively, and designated Mystère IIA, differed from the Mystère I in having the 6,280 lb. thrust Hispano-Suiza Tay 250 turbojet. Seventeen pre-production Mystère fighters had been ordered in April 1951, and three of these were Tay-powered but differed from the Mystère IIA in having the built-in armament of four 20-mm. cannon replaced by two 30-mm. cannon (Mystère IIB). Subsequent pre-production Mystères were powered by the S.N.E.C.M.A. Atar 101 turbojet, two being experimentally fitted with the afterburning Atar 101F of 8,380 lb. thrust.

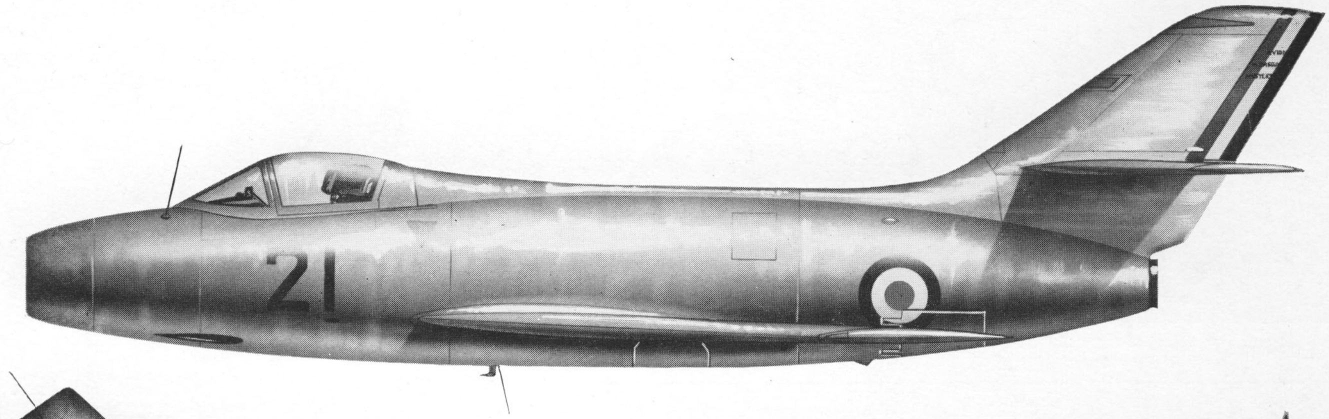
One hundred and fifty Mystère IIC fighters were ordered in April 1953, and these are to be powered by the 6,600 lb. thrust Atar 101D-3 turbojet. The Mystère IIC has a maximum speed of 658 m.p.h. at sea level and 581 m.p.h. at 39,370 ft. Initial climb rate is 8,460 ft./min. and endurance is 1 hr. 30 min. Built-in armament comprises two 30-mm. Hispano 603 cannon, empty and loaded weights are 11,514 lb. and 16,442 lb. respectively, and overall dimensions are: span, 38 ft. $1\frac{1}{2}$ in.; length 38 ft. 4 in.; height, 13 ft. $11\frac{3}{4}$ in.; wing area, 326·146 sq. ft.

A two-seat all-weather fighter version, the M.D.453 Mystère III, was flown on July 18, 1953. In order to accommodate the necessary radar equipment, the Tay 250 turbojet of the Mystère III had lateral air intakes in place of the nose intake to allow for the installation of A.I., gun-laying and tracking, navigation and transponder radar in the nose. Development was abandoned in favour of the more advanced Mystère IVN.

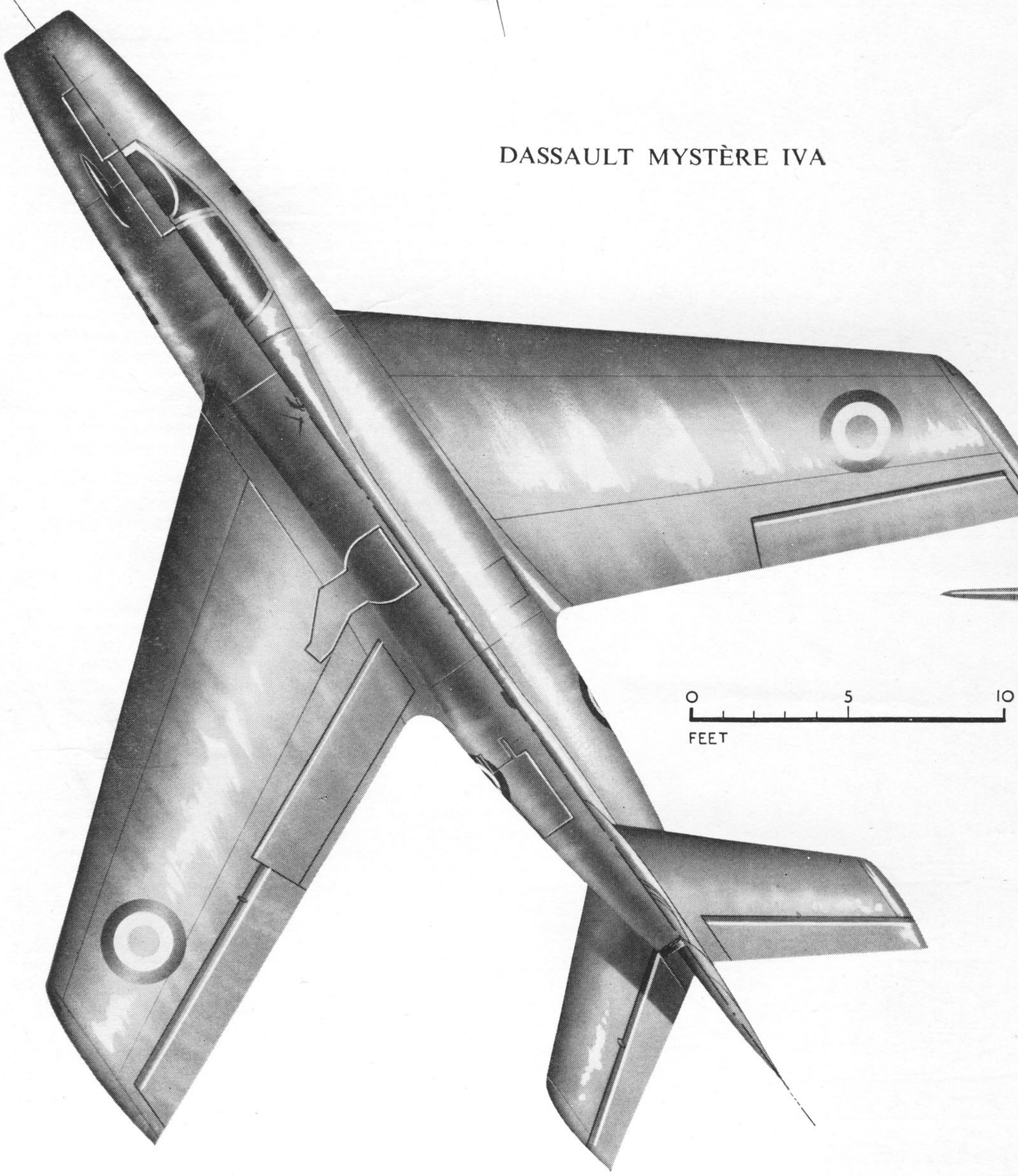
Simultaneously with development of the Mystère IIC, the Mystère IV had been developed, the prototype flying on September 28, 1952. The Mystère IV was, in fact, a complete redesign bearing only an external aerodynamic resemblance to the earlier model. An entirely new wing with thickness/chord ratio reduced from 9 to 7·5 per cent and sweepback increased to 38° at quarter-chord was married to a more robust, oval-section fuselage, and 225 Mystère IVA fighters were ordered in April 1953 under the U.S. Off-shore Procurement Programme. The first 75 Mystère IVAs are to be powered by the 6,280 lb. thrust Tay 250A turbojet and subsequent machines will have the 7,720 lb. thrust Hispano-Suiza Verdon. With the latter unit, the Mystère IVA has a top speed of 696 m.p.h. at sea level and 615 m.p.h. at 39,370 ft. Initial climb rate is 8,860 ft./min. and endurance is 1 hr. 10 min. Empty and loaded weights are 12,518 lb. and 16,314 lb. respectively, and dimensions are: span, 36 ft. $5\frac{3}{4}$ in.; length, 42 ft. $1\frac{3}{4}$ in.; height, 15 ft. 1 in.; wing area, 344·445 sq. ft.

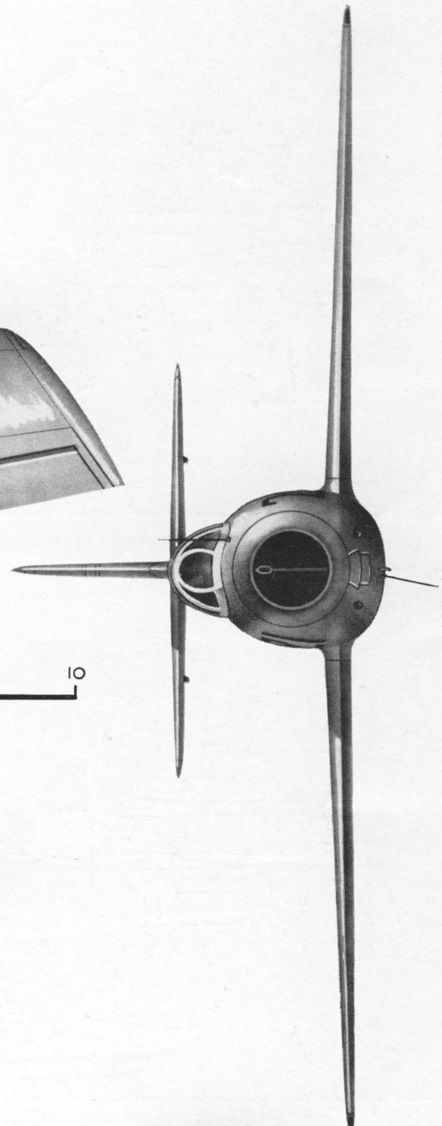
Several progressive versions of the Mystère IV are under development, including the Mystère IVB single-seat all-weather fighter and the Mystère IVN two-seat night fighter. Both versions are powered by the Rolls-Royce Avon R.A.7R of 7,500 lb. thrust and 9,500 lb. thrust with afterburning, an alternative unit being the Atar 101G–21 of 7,275 lb. thrust and 9,260 lb. with afterburning. The Mystère IVB differs externally from the IVA in having a lengthened rear fuselage (43 ft. $11\frac{1}{2}$ in.) to house the afterburner extension and a dielectric cap in a lip over the air intake. Internal differences include the revision of the air intake ducting which is led under the pilots' cockpit instead of dividing to pass on either side. This change has necessitated modification of the nosewheel retraction mechanism and housing, the nosewheel retracting backwards and turning through 90° to lie flat beneath the air duct. With afterburning, maximum speed is 740 m.p.h. at sea level, and initial climb rate is 22,047 ft./min. The prototype Mystère IVB flew on December 16, 1953. The Mystère IVN first flew on July 19, 1954, and has tandem seating for its two crew members and a large CSF radar housing above a chin-type air intake. As an alternative to the built-in armament of two 30-mm. cannon, fifty-two Brandt unguided air-to-air missiles can be carried in a retractable Matra 101 bis launching tray with nineteen additional missiles in each of four underwing pods.

The Mystère XX embodies a further increase in wing sweep (45°) and reduction in thickness/chord ratio (6%). Power is provided by a 9,500 lb. thrust Rolls-Royce Avon R.A.14 engine.

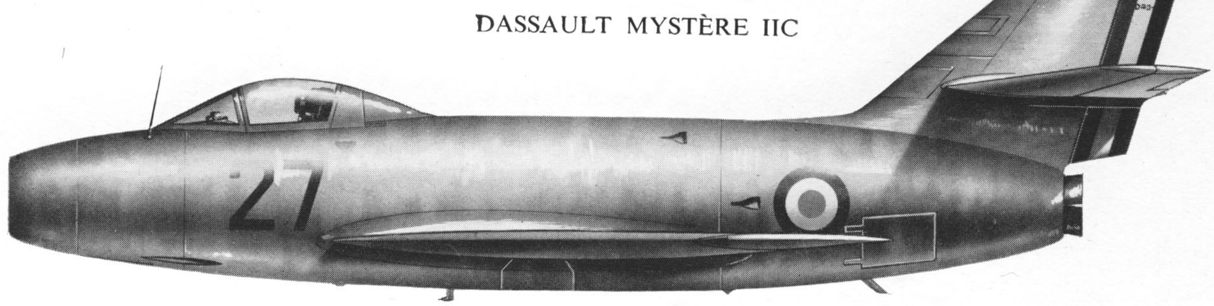


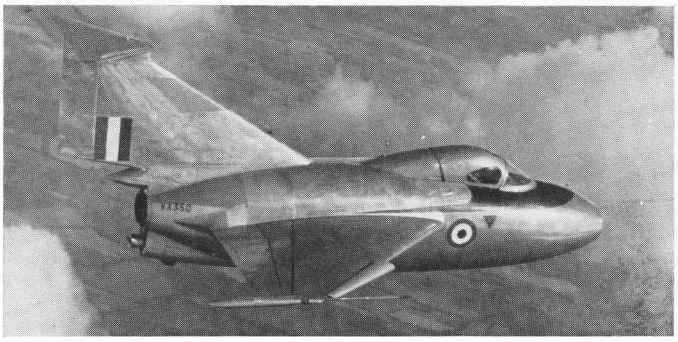
DASSAULT MYSTÈRE IVA

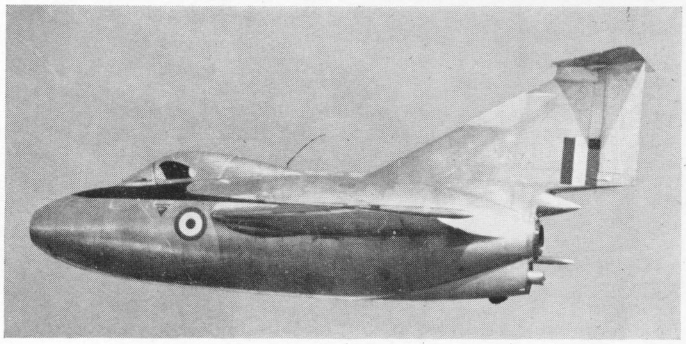




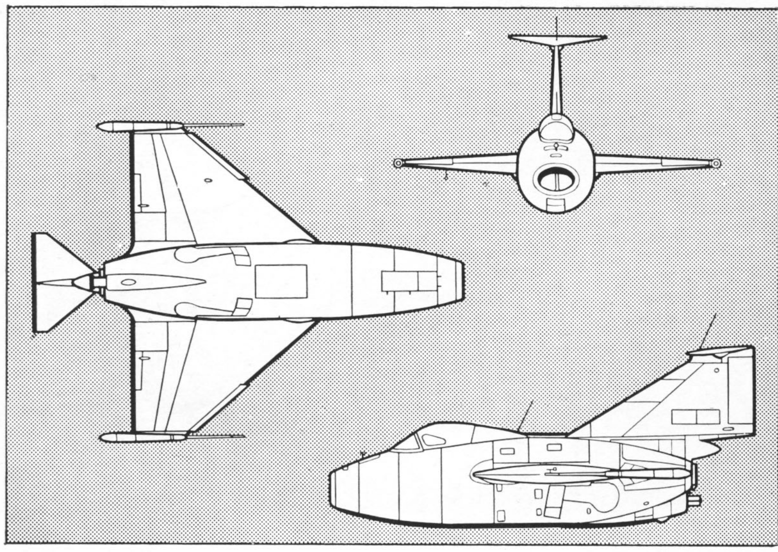
DASSAULT MYSTÈRE IIC







Originally designed as a vertical take-off fighter, the F.D.1 (VX350) was employed for delta research.

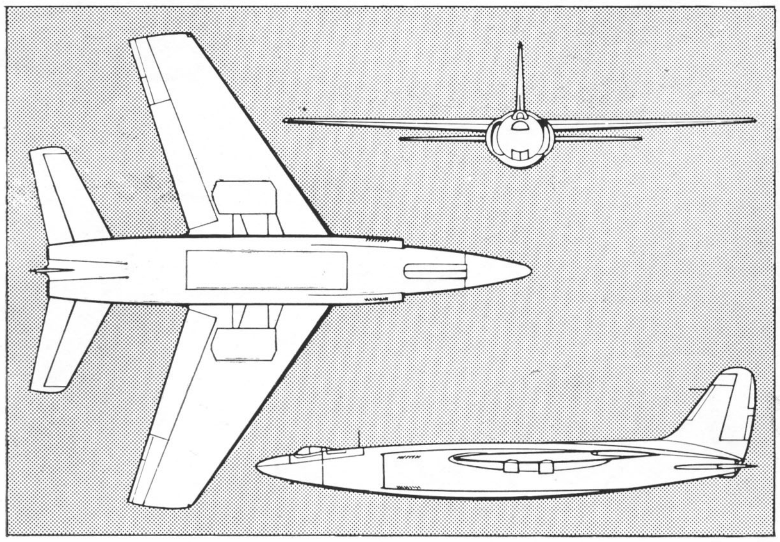


FAIREY F.D.I (MARCH) 1951

The Fairey F.D.1 was originally designed as a vertical take-off fighter, and embodied several novel features. It was intended that the F.D.1 should be launched from an inclined ramp, and power was to be provided by a special Rolls-Royce turbojet. A unique feature of the design was the means of control by the variation of the jet thrust from four nozzles grouped around the central turbojet efflux. The practicability of the F.D.1 project was proven by means of rocket-powered models which indicated that take-off accelerations would be acceptable. However, the Ministry of Supply decided that the F.D.1 should fulfil a more orthodox research role, and the design was modified to take a nosewheel undercarriage and a 3,600 lb. thrust Rolls-Royce Derwent 8 turbojet.

In this form, the F.D.1 flew for the first time on March 12, 1951. The fairings originally intended to house the exit ducts for directional control were retained for the initial flight tests, the lower fairing being adapted to house a brake parachute, but the side fairings were later removed. These fairings gave rise to incorrect reports that rocket motors were to be fitted. Wing-tip fairings contained anti-spin parachutes, and flying controls comprised elevons and a rudder. A small horizontal tail surface was fitted, although this was not a true control surface—the F.D.1 was, in fact, the first delta to be flown with horizontal tail surfaces.

The most noteworthy features of the F.D.1 were its small overall dimensions, span and length being only 19 ft. 6½ in. and 26 ft. 3 in. respectively. To the present time the F.D.1 is the smallest piloted delta to have flown.



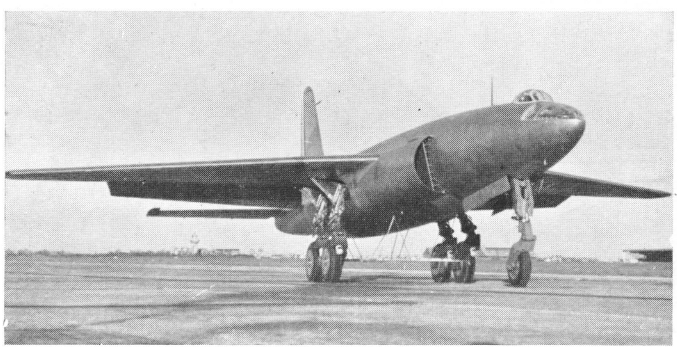
SUD-OUEST S.O.4000 (MARCH) 1951

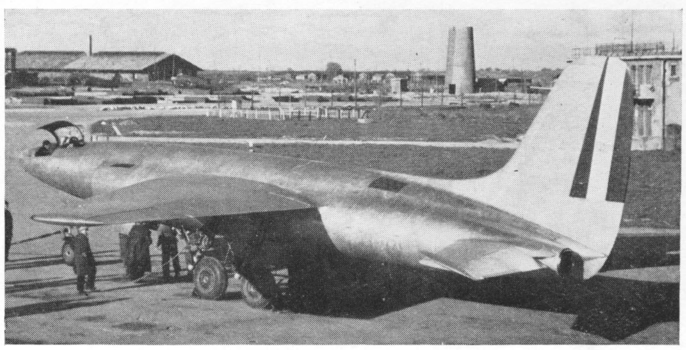
The S.O.4000 was a two-seat light bomber of extremely novel configuration. The high-mid wing was mounted at approximately mid point on the disproportionately large fuselage and was swept 31° on the main spar. Its 10 per cent thickness/chord ratio was constant from root to tip, and the small ailerons at the wing-tips were coupled with spoilers for lateral control. Large-chord flaps extended across nearly the whole wing trailing edge.

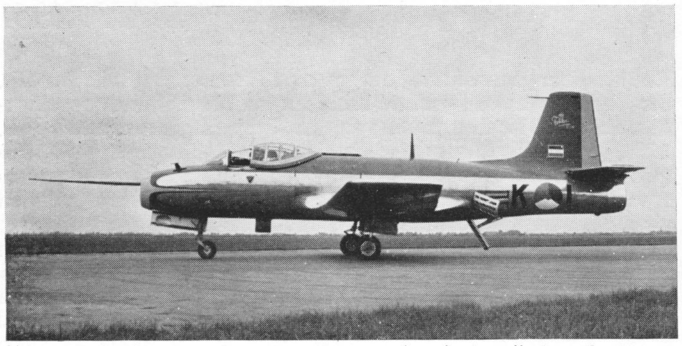
The deep, circular-section fuselage carried a crew of two in tandem in a small pressurised cockpit close up to the nose. Above the bomb-bay in the centre fuselage were fuel tanks with a total capacity of 1,430 Imp. gal., and the rear fuselage housed two 5,000 lb. thrust Hispano-Suiza Nene 102 turbojets mounted side by side and exhausting below the vertical tail surfaces. The turbojets were fed via lateral intakes aft of the pressurised forward fuselage, and the exceptional length of the intake ducts must have resulted in heavy thrust losses which may, in part, have accounted for the relatively low performance. The undercarriage was also of novel configuration, the four mainwheel members each having independent legs. It was proposed that two remotely controlled guns should be mounted in each of two wing-tip barbettes.

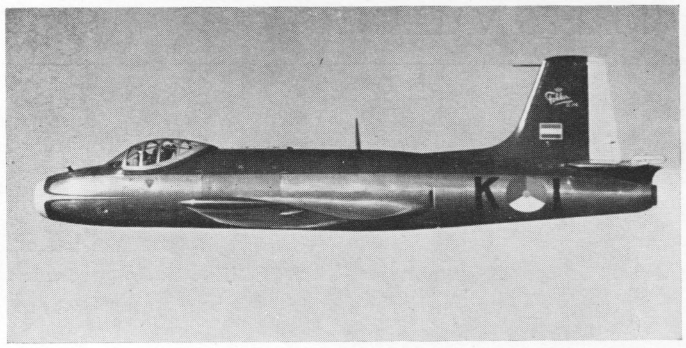
The S.O.4000 flew on March 16, 1951, but further flight trials were abandoned. Empty and loaded weights were 36,558 lb. and 48,510 lb. respectively, and estimated performance included a maximum speed of 528 m.p.h. at 29,528 ft. and a cruising speed of 515 m.p.h. at sea level. Dimensions were: span, 58 ft. 7 in.; length, 64 ft. 10 in.; wing area, 807 sq. ft.

The S.O.4000 experimental light bomber was of novel but unsuccessful design, flying only once.









(Above, left) *The prototype Mach-Trainer after the installation of a Nene turbojet.* (Above, right, and drawing) *The prototype with a Derwent turbojet.*

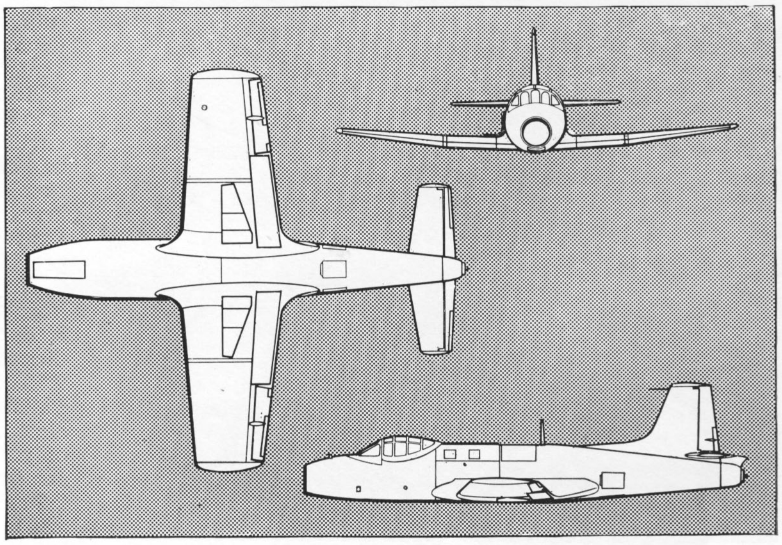
FOKKER S.14 MACH-TRAINER (MAY) 1951

The first jet-propelled aircraft to be designed from the outset for the conversion training role, the S.14 Mach-Trainer was developed to instruct pupils in the differences in flying technique between piston-engined and jet-propelled aircraft without the concentration called for by the more difficult handling qualities of two-seat conversions of standard single-seat fighters.

Accommodating pupil and instructor side by side, the prototype Mach-Trainer flew for the first time on May 20,1951, powered by a 3,470 lb. thrust FNA-built Rolls-Royce Derwent 8, and a production series of twenty machines has been ordered by the Royal Netherlands Air Force. An additional fifty Mach-Trainers are to be built in Brazil by Fokker Industria S.A.do Brazil. In 1953 the Derwent turbojet of the prototype was replaced by a 5,100 lb. thrust Rolls-Royce Nene 3, in which form the aircraft was known as the Mach-Trainer II.

The Derwent- and Nene-powered Mach-Trainers have the following weights and performances (figures for the latter being quoted in parentheses): empty weight, 8,304 (8,745) lb., loaded, 11,800 (12,230) lb.; maximum speed, 445 (516) m.p.h. at 20,000 ft., cruising, 366 (386) m.p.h. at 30,000 ft.; initial climb rate, 3,200 (5,400) ft./min.; range, 620 (565) miles.

For armament training two 20-mm. guns in a detachable tray can be attached to the fuselage belly, and eight 3-in. rockets can be carried under the wing. Overall dimensions: span, 39 ft. 5 in.; length, 43 ft. 8 in.; height, 15 ft. 4 in.; wing area, 342 sq. ft.

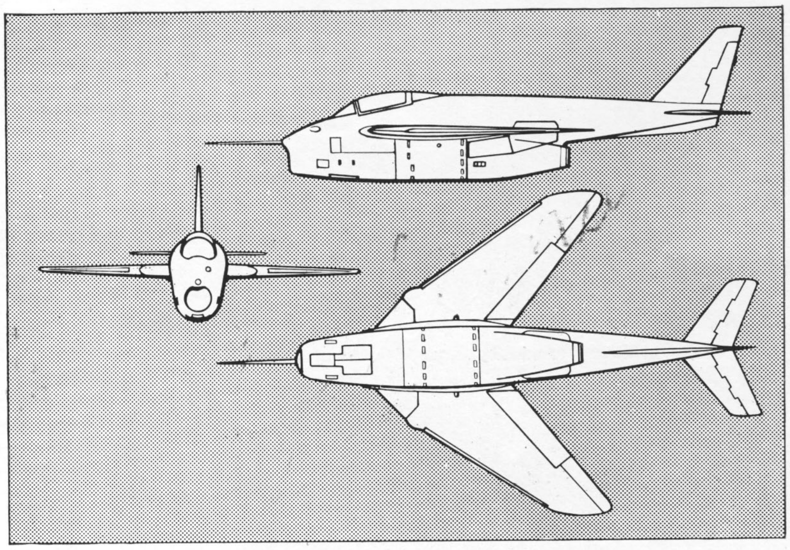


BELL X–5 (JUNE) 1951

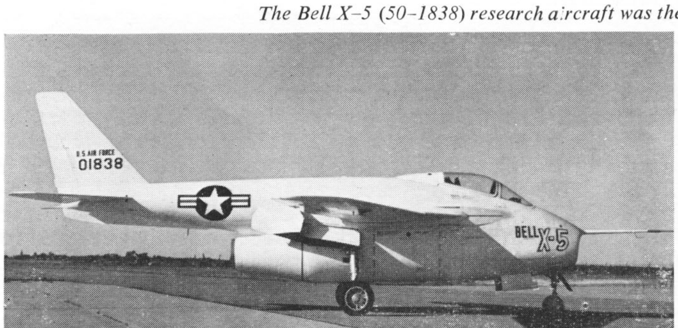
The Bell X–5 was built to investigate the aerodynamic effects of changing the angle of wing sweep in flight. The variable-sweep wing offers a fighter considerably increased operational flexibility, as it eliminates the low-speed handling problems associated with sharply swept wings and enables the pilot to reduce or increase the critical Mach number. The X–5 was therefore built to full tactical fighter requirements in order that it could be evaluated by the U.S.A.F. as a combat type.

Design of the X–5, which was initiated towards the end of 1948, was based upon that of the German Messerschmitt P.1101 (page 12), and the first of two machines flew on June 20, 1951. The X–5 was powered by a 4,900 lb. thrust Allison J35–A–17 turbojet, and a projected alternative power plant was the Westinghouse XJ40–WE–2 with afterburner, although neither this unit nor afterburning equipment was fitted.

The operating mechanism changing the sweepback angle of the wing automatically compensated for the resultant shift of the centre of gravity, and a specially designed fairing ensured the maintenance of smooth airflow at the wing roots regardless of the sweepback angle. Full-span leading edge slats were fitted, and the wing-sweep angle could be varied from 20° to a maximum of 60°. At minimum sweep angle the maximum speed was 605 m.p.h., but at maximum sweep this was increased to 650 m.p.h. Loaded weight was 9,892 lb.; and dimensions were as follows: span (20° sweep) 31 ft. $9\frac{1}{2}$ in., (60° sweep) 20 ft. $9\frac{1}{2}$ in.; length, 33 ft. 6 in.; height, 9 ft. 9 in.; approximate gross wing area, 175 sq. ft. The complexity of the variable-sweep wing has so far precluded its widespread use.

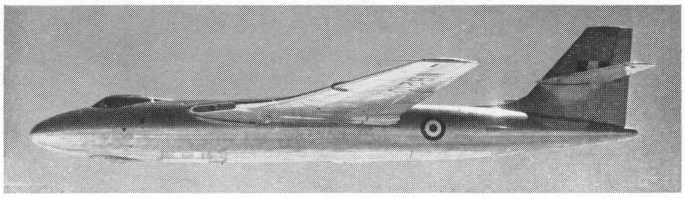


The Bell X–5 (50–1838) research aircraft was the first such machine to have a variable-sweep wing.

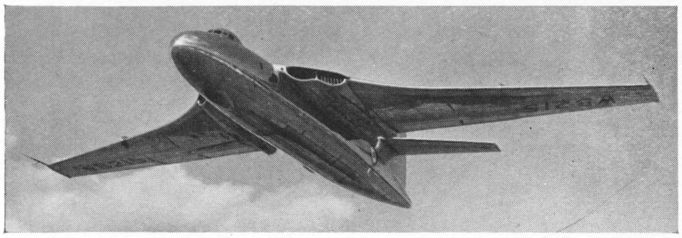


VICKERS VALIANT

(MAY) 1951

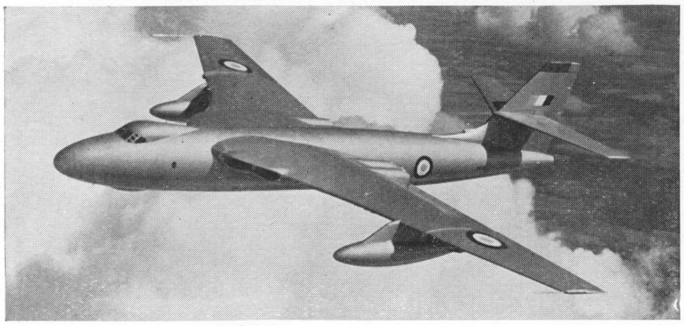


(Above) *The Type 660 first prototype Valiant (WB210) with slot-type intakes.*

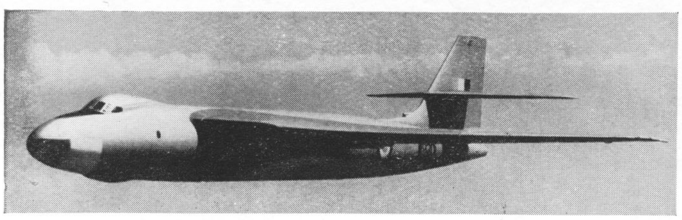


(Above and below) *The Type 667, the second prototype Valiant (WB215).*

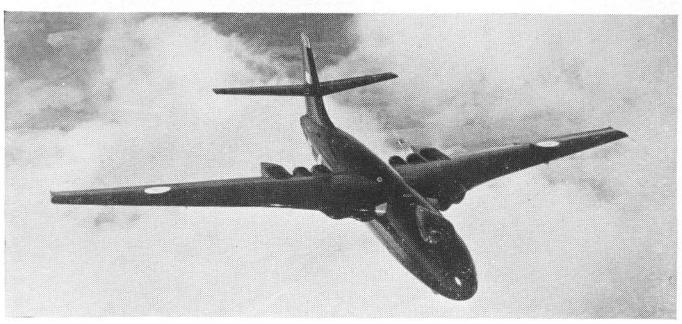
(Below) *The Type 667 fitted with auxiliary fuel tanks.*



(Below) *An early production Type 674 Valiant B.1 (WP201).*



(Below) *The experimental "pathfinder" Type 673 Valiant B.2 (WJ954).*



The first four-jet medium-bomber to enter service with the R.A.F., the Valiant was designed to meet the requirements of specification B.9/48. The first prototype, the Type 660, flew on May 18, 1951, powered by four 6,500 lb. thrust Rolls-Royce Avon R.A.3 turbojets, and was followed on April 11, 1952, by a second prototype, the Type 667. The latter differed externally in having lipped air intakes in place of the slot-type intakes of the first prototype, and was later powered successively by the 7,500 lb. thrust Avon R.A.7 and 9,500 lb. thrust Avon R.A.14.

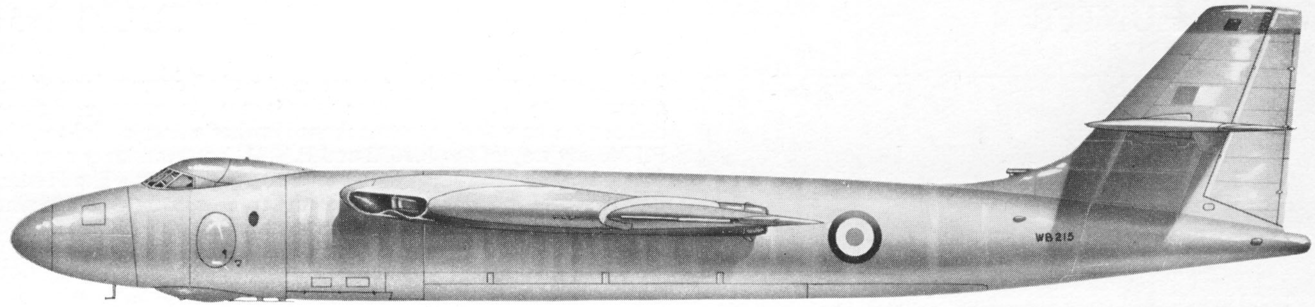
The Valiant has a high-mounted wing of generous area with a mean sweepback of some 20°. The leading edge has compound sweep, the inboard sections being swept 45° in order that the depth necessary to house the turbojets will not reduce the critical Mach number. The four Avon engines are almost completely submerged and, therefore, offer negligible drag. Double-slotted flaps are fitted, which, together with a relatively low wing loading, confer an exceptional take-off performance on the Valiant. The undercarriage has paired mainwheels in tandem which retract into bays between the wing roots and the outer panels. The circular-section fuselage has a diameter of approximately 11 ft. and carries the crew of five grouped together in the pressurised nose section. The tail surfaces are slightly swept and of low-aspect ratio, and the tailplane is carried high on the fin to avoid the turbulent wing wake. A small intake in the dorsal fairing provides air to a combustion heater for de-icing the tail surfaces.

The initial production version for the R.A.F., the Type 674 Valiant B.1, differs little externally from the second prototype and is distinguishable only by slightly lengthened tail-pipes and dielectric panelling in the nose section. Power is provided by four 9,500 lb. thrust Avon R.A.14 turbojets, but later production Valiants will have 10,000 lb. thrust Avon R.A.28, and overall dimensions are: span, 114 ft. 4 in.; length, 108 ft. 3 in. No details of performance are available for publication, but it can be assumed that the Valiant B.1 will cruise at speeds between Mach 0·9 and 0·95 (587–623 m.p.h.) at altitudes in excess of 50,000 ft. and that normal range is of the order of 3,000 miles. Range can be extended by the addition of large auxiliary fuel tanks mounted on and projecting forward of the outboard wing sections. Such tanks were first fitted to the second prototype Valiant, which was entered for (but did not participate in) the England–New Zealand Air Race. The planned route is indicative of the Valiant's long-range abilities, as it comprised only three stages, the longest of which was some 5,000 miles. Normal loaded weight is likely to be of the order of 120,000 lb., although maximum loaded weight will probably exceed 150,000 lb.

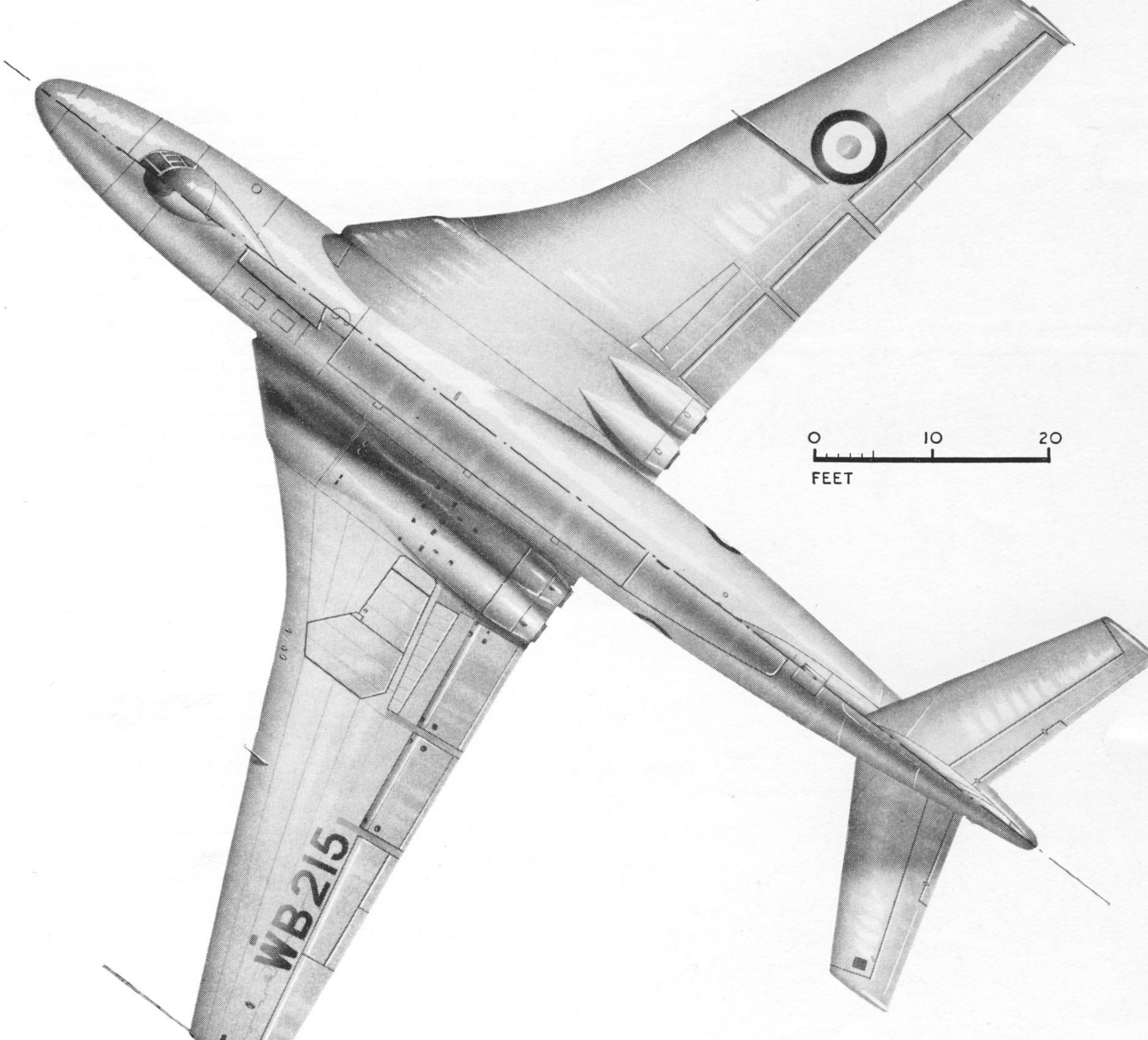
Various progressive developments of the Valiant are proposed, including the Type 710, a long-range photographic-reconnaissance version. An experimental variant which has not been placed in production is the Type 673 Valiant B.2, which, powered by four 9,500 lb. thrust Avon R.A.14 turbojets, flew on September 4, 1953.

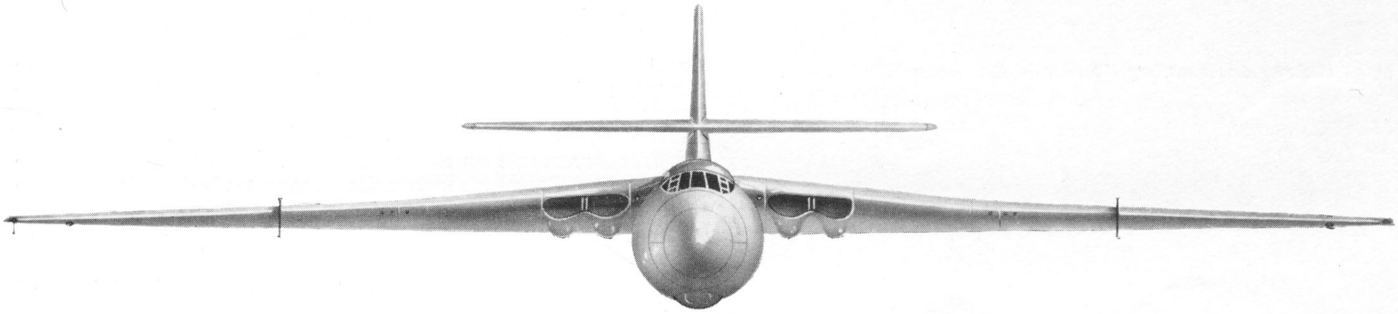
Developed for the "pathfinder" role, the Valiant B.2 differs extensively from the B.1, the most notable change being the lengthening of the fuselage by the insertion of an additional bay ahead of the wing increasing fuselage length to 114 ft. Another notable difference between B.1 and B.2 is to be seen in the unusual undercarriage geometry employed by the latter, the main undercarriage members comprising four-wheel bogies retracting rearwards into prominent streamlined fairings extending aft from the wing trailing edge. Reports suggest that these fairings were originally intended to act also as housings for de Havilland Super Sprite rocket units for auxiliary take-off and climb power. Such take-off augmentation would enable the Valiant to carry increased loads or use shorter runways.

A long-range military transport owing much to the design of the Valiant is currently under construction for R.A.F. Transport Command. The transport's wing planform is basically a scaled-up version of that employed by the Valiant, and construction of a prototype designated Type 1000 commenced in February 1953. The Type 1000 is to be powered by four Rolls-Royce R.B.82 Conway R.Co.3 turbojets of some 11,500 lb. thrust each, and will have a span and length of 140 ft. and 146 ft. respectively. Believed to be designed for a cruising Mach number in excess of 0·9, it is likely to possess a maximum loaded weight of more than 220,000 lb. The production model is designated Type 1002, and a projected commercial version is known as the Type 1004, or V.C.7.



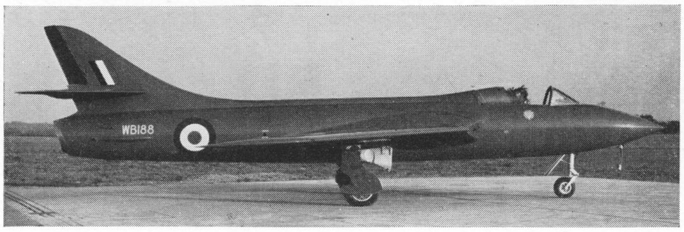
VICKERS VALIANT (SECOND PROTOTYPE)



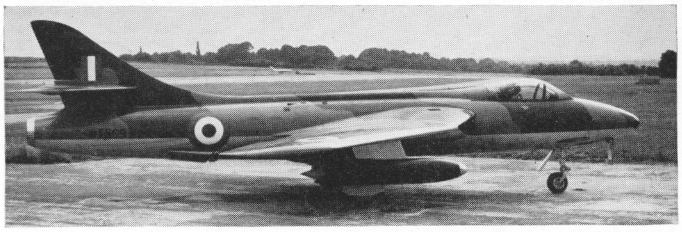


HAWKER HUNTER

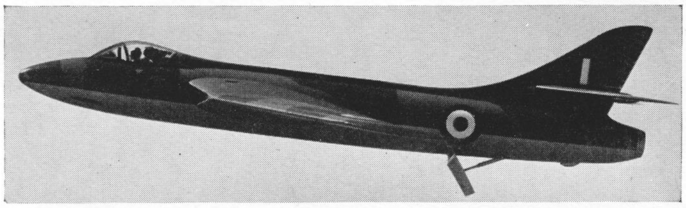
(JULY) 1951



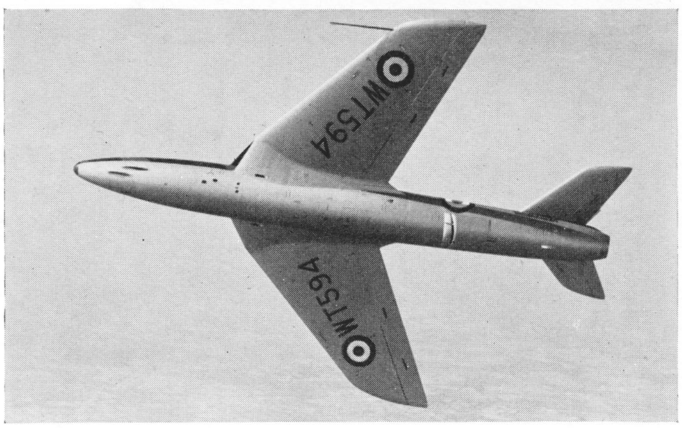
(Above) *The Hunter F.1 prototype (WB188) modified to F.3 standards.*



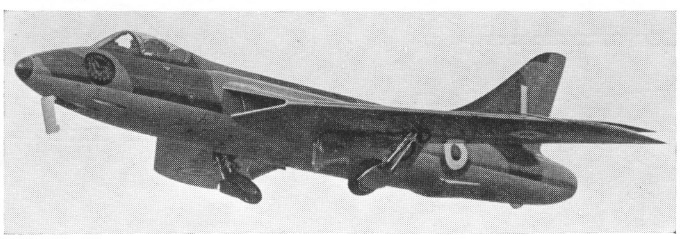
(Above) *A production Hunter F.1 (WT569) with drop-tanks.*



(Above and below) *A production Hunter F.1 (WT594).*



(Below) *An Armstrong Whitworth-built Hunter F.2 (WN909).*



Aesthetically one of the most appealing of all current jet combat aircraft, the P.1067 Hunter single-seat interceptor fighter, although a new design, stems from Hawker's first jet fighter, the P.1040, by way of the P.1052 and P.1081, but bears only a superficial resemblance to its Nene-powered progenitors. The Hunter is considerably larger than the earlier machines, and its slim fuselage has been designed around an axial-flow turbojet.

The first of two Avon-powered prototypes flew on July 20, 1951, the second flying on May 5, 1952. On September 7, 1953, the first prototype fitted with an afterburning Rolls-Royce Avon R.A.7R turbojet, developing 9,500 lb., raised the World Air Speed Record to 727·6 m.p.h. The third prototype Hunter, which flew on November 30, 1952, differed from its predecessors in having the Avon turbojet replaced by an Armstrong Siddeley Sapphire in a slightly lengthened fuselage.

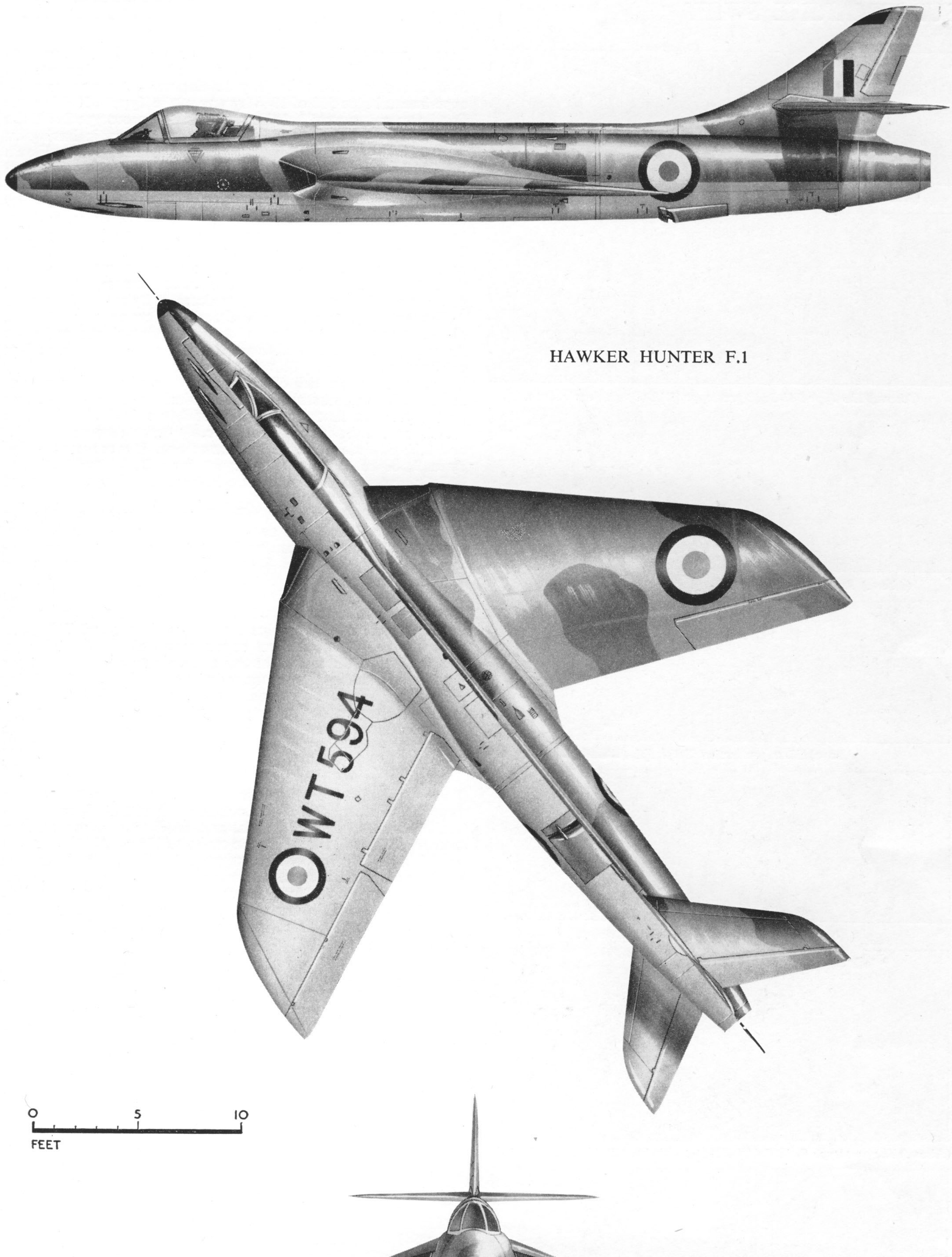
Both Avon- and Sapphire-powered Hunters have been ordered in quantity, the initial production version with each turbojet being designated Hunter F. 1 and F. 2 respectively. Externally the F.1 and F.2 variants are virtually identical, production of the latter being entrusted to Sir W. G. Armstrong Whitworth Aircraft Ltd. The first production Hunter F.1 flew in May 1953. The Hunter F.3 was a proposed production version with an afterburning Avon R.A.7R.

While no official pronouncements concerning details of later production variants have been made, the existence of two further Avon-powered models, the Hunter F.4 and F.6, has been revealed. The Hunter F.4 and F.6 are also to be built under licence in the Netherlands and Belgium for the Dutch and Belgian air forces, and official Dutch sources state that the two variants are powered by the 8,000 lb. thrust Avon R.A.21 and 10,000 lb. thrust Avon R.A.23 respectively. The Avon R.A.21 and R.A.23 turbojets for both Dutch- and Belgian-built Hunters are being manufactured by the Belgian *Fabrique Nationale des Armes de Guerre*, and the Dutch Fokker company and the Belgian Fairey and S.A.B.C.A. companies currently possess orders for 204 and 192 Hunters respectively. The Hunter F.4 embodies various internal improvements, and, presumably, increased internal fuel capacity.

The Hunter F.1 is powered by an uprated Avon R.A.7 series turbojet fed by air intakes in the swollen wing roots and exhausting beneath the tail assembly. The fuselage length is 45 ft. 10½ in., as compared to 45 ft. 3 in. for the Avon-powered prototypes, and the span of the wing is only 33 ft. 8 in. The wing is swept 30° at 25 per cent chord and houses the main members of the wide-track undercarriage. Its planform is generally similar to that employed by the earlier P.1052 and P.1081, but chord has been increased, resulting in a slightly reduced sweep angle, and the trailing-edge root fillets deleted. At one time a project existed for a version of the Hunter embodying an additional 7° sweep on the mainspar.

A one-piece semi-circular air brake is mounted externally under the rear fuselage, hinging forwards. Various forms of air break surfaces were tested on the prototypes prior to the adoption of the one-piece under-fuselage brake, including individual surfaces at the fuselage sides. To simplify rearming and servicing the armament of four 30-mm. Aden cannon is carried in a pack which can be lowered from the fuselage by means of cables. A variety of underwing ordnance loads can be carried for ground attack duties. Alternatively, jettisonable fuel tanks can be carried. All tail surfaces are swept and overall height is 10 ft. The Hunter F.2 differs from the previously described F.1 only in having an Armstrong Siddeley Sapphire turbojet of the 8,000 lb. thrust A.S.Sa. 6 variety. It would seem likely that later production models of the Sapphire-powered Hunter will employ turbojets of the 10,200 lb. thrust Sapphire A.S.Sa.7 type.

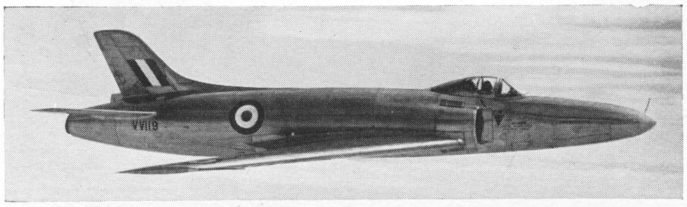
No details of the Hunter's performance have been revealed; and while the initial production versions are unlikely to be capable of exceeding Mach unity in level flight, it is reasonable to suppose that later Hunters, having available the increases in thrust to be expected from fully developed Avons and Sapphires, *will* be supersonic on the level. In addition to the R.A.F., the Belgian and Dutch air forces, the Hunter has been ordered by the Danish and Swedish air forces. The latter air arm will receive an export version of the Hunter F.4 which, in Swedish service, will be known as the J 34. A two-seat conversion trainer variant of the Hunter was proposed at one time, but development has been discontinued.



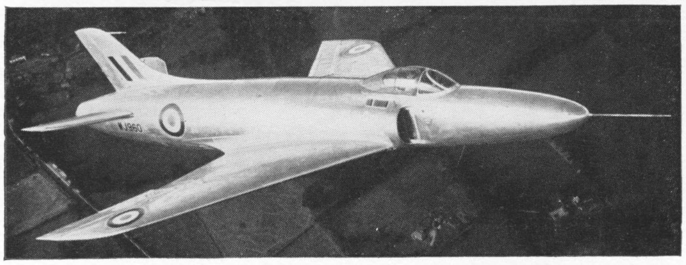
HAWKER HUNTER F.1

SUPERMARINE SWIFT

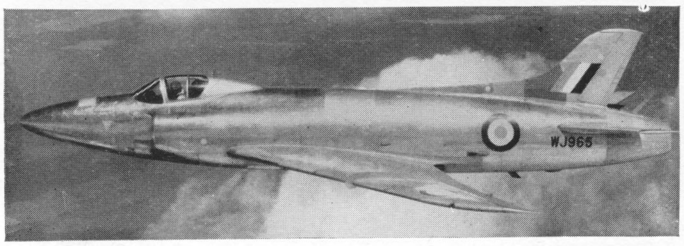
(AUGUST) 1951



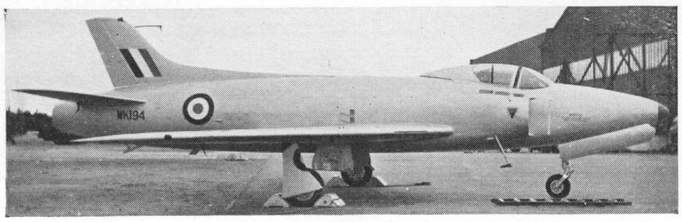
(Above) *The Supermarine Type 535 (VV119) with Nene turbojet.*



(Above) *The Type 541 Swift prototype (WJ960) with early Avon.*

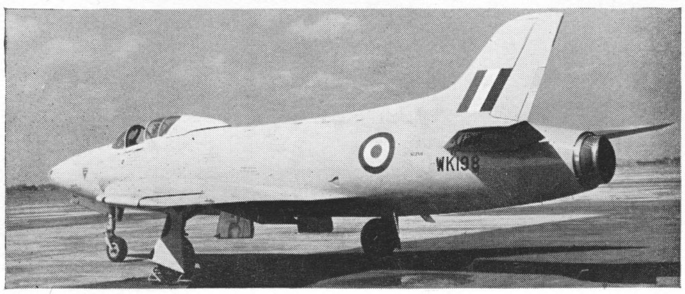


(Above) *Production prototype Swift F.1 with redesigned nose.*

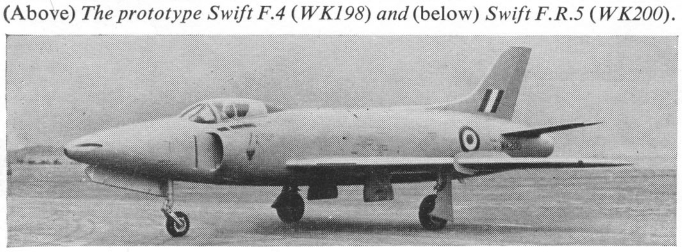


(Above) *First production Swift F.1 (WK194).*

(Above) *Swift F.2 fighters awaiting delivery.*



(Above) *The prototype Swift F.4 (WK198) and* (below) *Swift F.R.5 (WK200).*



Like its compatriot, the Hawker Hunter, with which it serves as standard R.A.F. single-seat interceptor fighter equipment, the Swift is the outcome of lengthy development. It stems from the experimental type 510 of 1948 by way of the Type 535 which was first flown on August 23, 1950. The first true prototype Swift, the Type 541, differed essentially from its precursors in having an axial-flow Avon turbojet in place of the centrifugal Nene. Flown for the first time on August 1, 1951, the Type 541 also differed from the Type 535 in having wing-tips of modified plan, simplified air brakes, a redesigned fuel system which ensured continuity of supply despite combat damage to individual tanks, and the transfer of the armament bays from the wing to the fuselage. The Type 541 retained the deep fuselage necessitated by the centrifugal engine of the Type 535, the surplus space provided by the slim axial-flow engine being utilised to increase the 600 Imp. gal. internal fuel capacity of its predecessor by some 25 per cent.

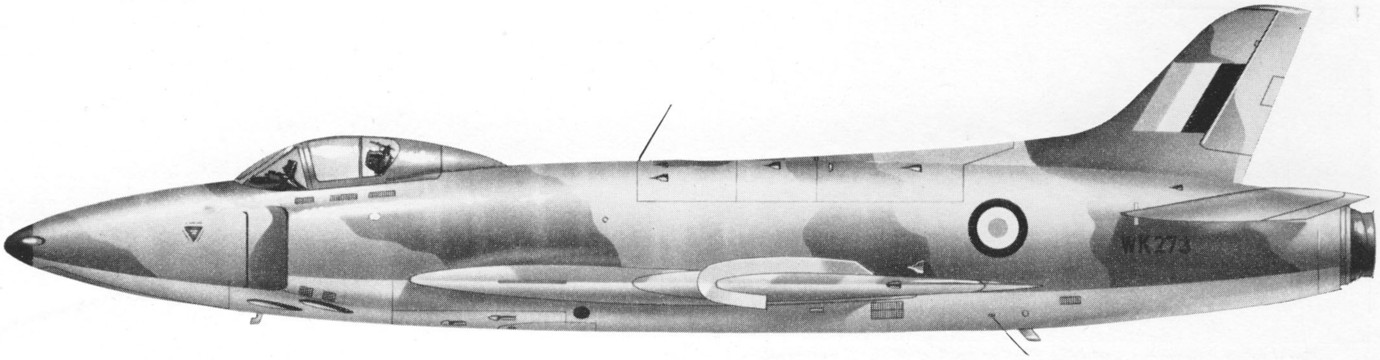
The production prototype Swift, which flew on July 18, 1952, differed from its predecessor in having lengthened intakes for the Avon engine, a redesigned forward fuselage and cockpit, and an enlarged dorsal fin. This prototype also incorporated fully powered controls which eliminated the lateral control problems at high Mach numbers which had limited the speed of the first prototype. The first production model, the Swift F.1, followed closely on the production prototype, flying on August 25, 1952, and differed little from the earlier machine. Power was provided by a 7,500 lb. thrust Rolls-Royce Avon R.A.7 turbojet, and built-in armament comprised two 30-mm. Aden cannon installed in the forward fuselage.

The original specification called for an armament of only two 30-mm. guns, but a later decision to standardise on a four-gun armament for new interceptor fighters led to some revision to incorporate two additional 30-mm. Aden guns, resulting in the interim Type 546 Swift F.2. The two additional guns were installed under the air intakes and, to provide space for the extra ammunition tanks, the inboard wing panels were extended, increasing their leading-edge sweep angle to some 50°. The sweep angle of the outboard panels remained at 40°. A further progressive development, the Swift F.3, which also featured the compound leading-edge taper, was fitted with the afterburning Avon R.A.7R, which increased static thrust to 9,500 lb.

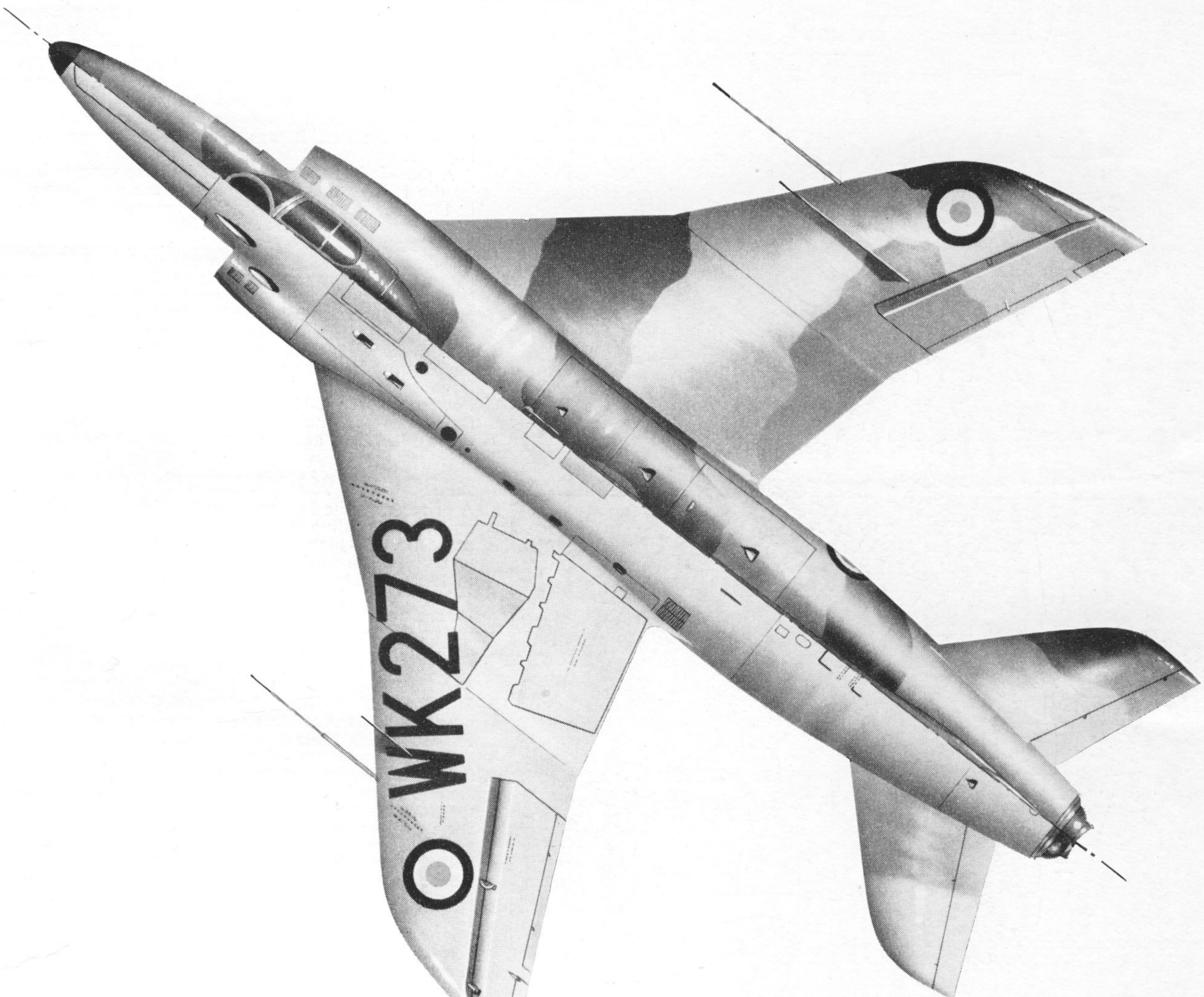
The first major production model, the Swift F.4, incorporated the improvements introduced on the F.2 and F.3 and, in addition, was fitted with a variable-incidence tail. The prototype Swift F.4 flew on May 27, 1953, and on September 25, 1953, raised the World Air Speed Record to 737·7 m.p.h. Prior to this, on July 5, 1953, the Swift F.4 prototype flew from London to Paris in 19 min. 5·6 sec. and back to London in 19 min. 14·3 sec., representing speeds of 669·3 m.p.h. and 664·3 m.p.h. respectively, over the 212·5 miles between the capitals. The production model Swift F.4 differs from the prototype in having taller vertical tail surfaces of increased area. The wing has a small span (32 ft. 4 in.) but the aspect ratio is low, and the gross wing area of 306 sq. ft. suggests a reasonable loading. The fuselage has a length of 41 ft. 5½ in., and large lateral intakes feed the Rolls-Royce Avon R.A.7R turbojet.

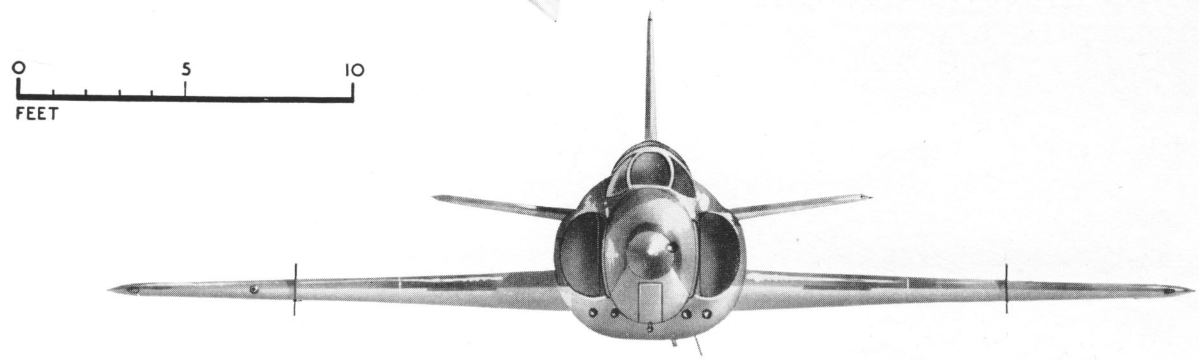
Internal fuel capacity of 778 Imp. gal. (500 gal. in rear fuselage, 98 gal. immediately aft of the cockpit and 90 gal. in each wing root) can be supplemented by a large external drop-tank under the centre fuselage. All tail surfaces are swept and tailplane span is 12 ft. 11 in. The undercarriage is of retractable nosewheel type, the main members, which have a track of 15 ft. 2½ in., retracting into inboard wing bays. The built-in armament of four 30-mm. Aden guns can be augmented for ground attack by sixteen 90-lb. rocket projectiles or two 1,000-lb. bombs under the wing. No details of the performance of the Swift F.4 are available for publication, but the low-level speed attained by the prototype when raising the World Air Speed Record can usefully be noted, and the spectacular initial climb rate with afterburning may well exceed 15,000 ft./min. by a substantial margin. At high altitudes level speeds very close to Mach unity are likely to be attainable.

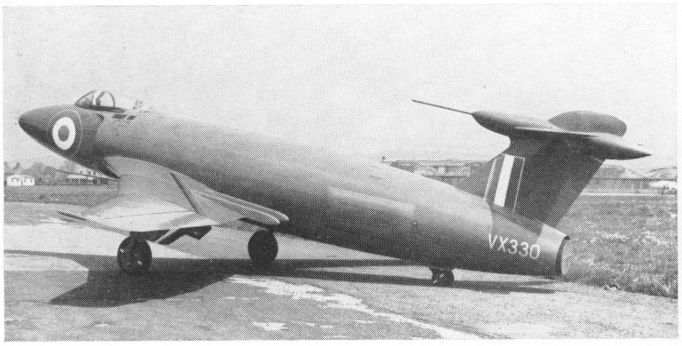
The latest variant of the Swift to be officially revealed is the Type 549 Swift F.R.5 fighter-reconnaissance aircraft. The Swift F.R.5 has a lengthened nose containing cameras. One camera is mounted in the extreme nose, flanked by the combat camera, and lateral oblique cameras are covered by doors forward of the air intakes.

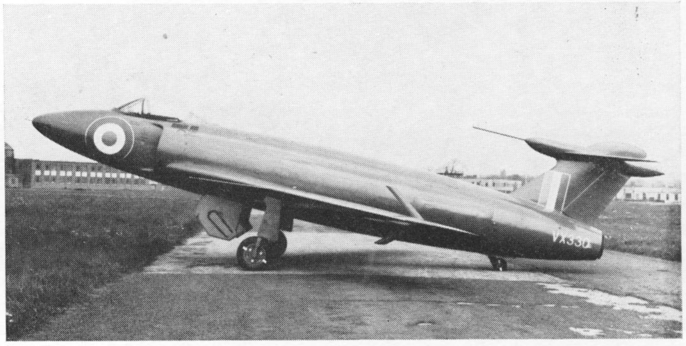


SUPERMARINE SWIFT F. 4

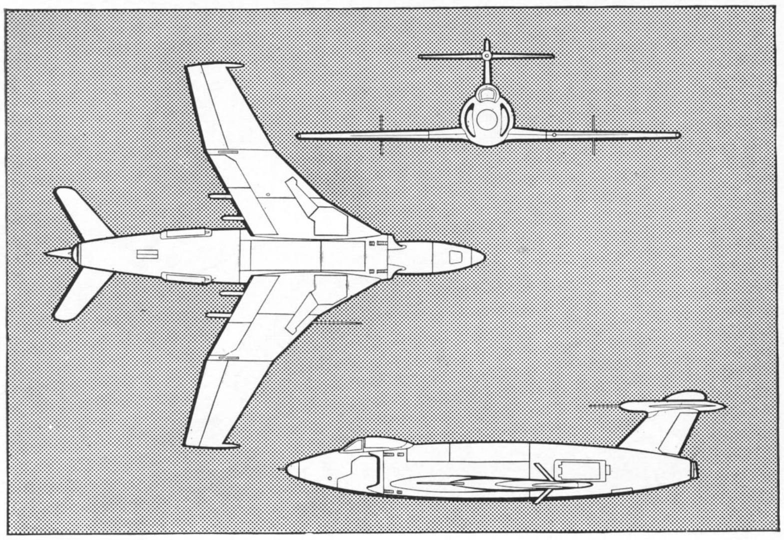








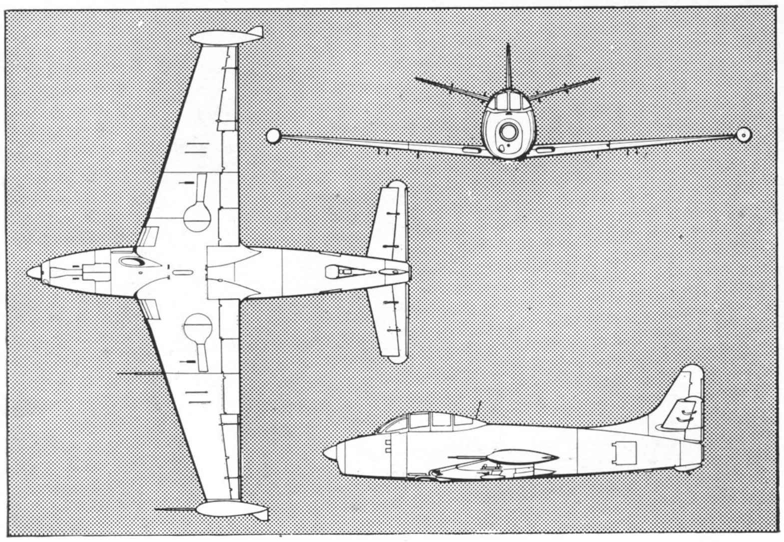
Employing a fuselage basically similar to that of the Supermarine Attacker, the H.P.88 was built to test the characteristics of the 'crescent' wing.



HANDLEY PAGE H.P.88 (JUNE) 1951

The Handley Page H.P.88 research aircraft was built to investigate the characteristics of the crescent-wing planform in which the critical Mach number was maintained constant by progressive reduction of sweepback and thickness ratio along the span. Research on wing planforms of this type had been initiated in 1944 by the German Blohm und Voss and Arado concerns and, as the crescent wing offered sufficient depth in the highly swept inboard sections for the buried installation of engines, undercarriage and fuel tanks, and the thin outer sections of reduced sweep promised good stalling and aero-elastic properties, it was chosen for the projected H.P.80 bomber.

A modified quarter-scale model of the wing to be employed by the H.P.80 was built by Blackburn and General Aircraft in 1948 and fitted to a special Supermarine fuselage, generally similar to that of the Type 510, designated Type 521, the resultant hybrid being initially known as the Blackburn Y.B.2 and later as the H.P.88. The wing of the H.P.88 possessed three degrees of sweepback and featured "droop-snoot" leading edges on the outboard sections, unusually large, rearward-moving, trailing-edge flaps of high-lift design, increasing the wing area as they moved down and aft, and a span of some 30 ft. The new swept vertical tail surfaces carried an all-movable, single-piece tailplane near to their tip, and large air brakes were mounted at the sides of the 39-ft. fuselage. Powered by a 5,100 lb. thrust Rolls-Royce Nene 102 turbojet, the H.P.88 was intended to test the characteristics of the wing up to Mach 0·9, and flew for the first time on June 21, 1951.



BREGUET 960 VULTUR (AUGUST) 1951

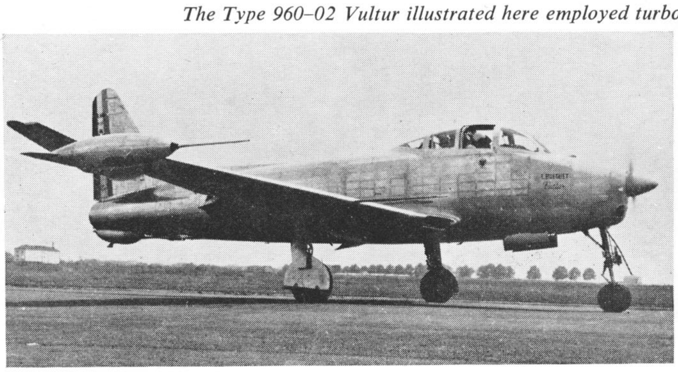
A prime requisite in a naval strike aircraft is good endurance, and an interesting attempt to combine this desirable characteristic with high performance is to be seen in the Breguet 960 Vultur carrier-borne attack aircraft, which was designed in 1948 to meet French naval requirements. The Vultur is a twin-engined aircraft with a small, nose-mounted turboprop for cruising flight and a turbojet for use at take-off and combat.

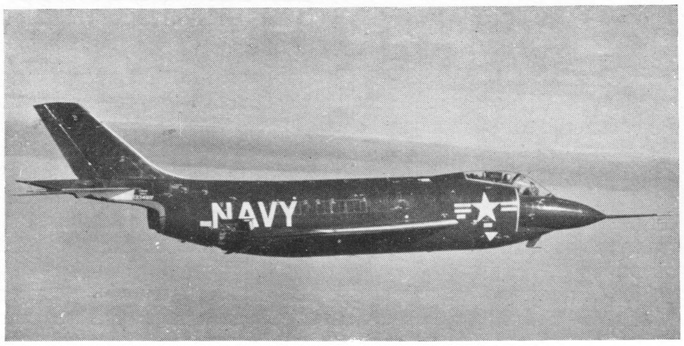
The first prototype, the Type 960–01, flew for the first time on August 3, 1951, powered by a 980 s.h.p. Armstrong Siddeley Mamba A.S.Ma.1 turboprop and a 4,850 lb. thrust Hispano-Suiza Nene 101 turbojet. This was followed on September 15, 1952, by the Type 960–02, powered by a 1,320 s.h.p. Mamba A.S.Ma.3 turboprop and a 5,000 lb. thrust Hispano-Suiza Nene 104 turbojet.

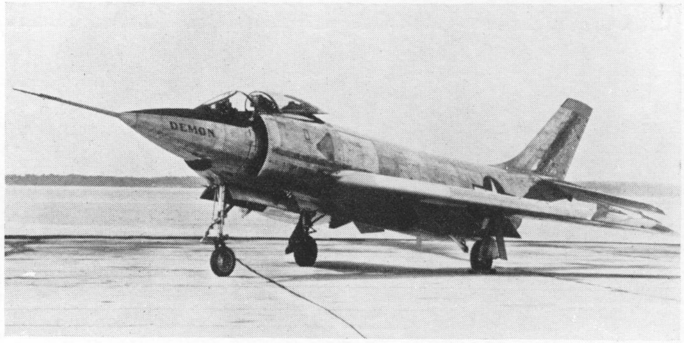
The aircraft was of all-metal stressed-skin construction and carried a crew of two seated side by side over the wing leading edge. The Type 960 could carry a 2,200-lb. bomb under the fuselage in addition to eight rocket projectiles under the wing, or various alternative offensive loads, and strike radar was carried in a housing at the starboard wing tip, this being balanced at the port wing tip by an overload tank. For anti-submarine duties a "guppy"-type search radar housing could be carried under the fuselage.

The Type 960–02 weighed 21,560 lb. loaded, and had a maximum speed of 555 m.p.h. on the power of both engines. Endurance, cruising at 230 m.p.h. on the power of the Mamba alone, was 4 hrs. Dimensions were: span, 54 ft. 3 in.; length, 43 ft. 4 in.; height, 16 ft. 11 in.; wing area, 393 sq. ft.

The Type 960–02 Vultur illustrated here employed turboprop for cruising and turbojet for take-off and combat.

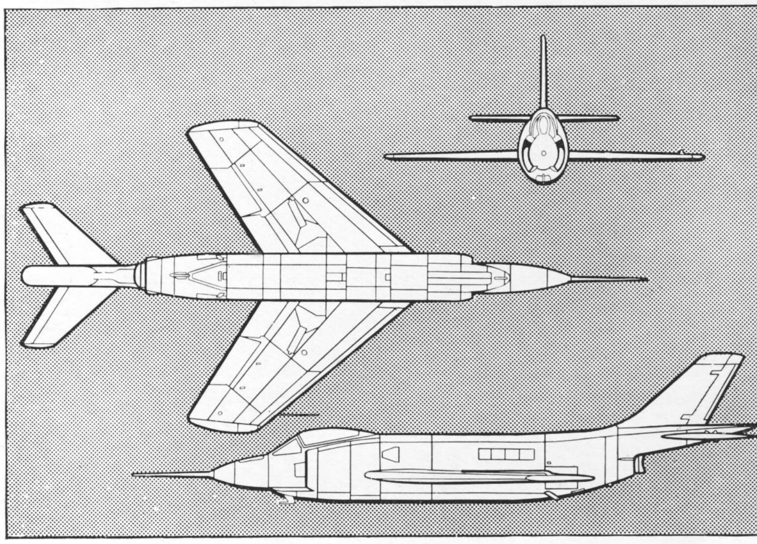






(Above, left and g.a. drawing) *The F3H–1N Demon.* (Above, right) *The second XF3H–I prototype Demon.*

McDONNELL DEMON (AUGUST) 1951

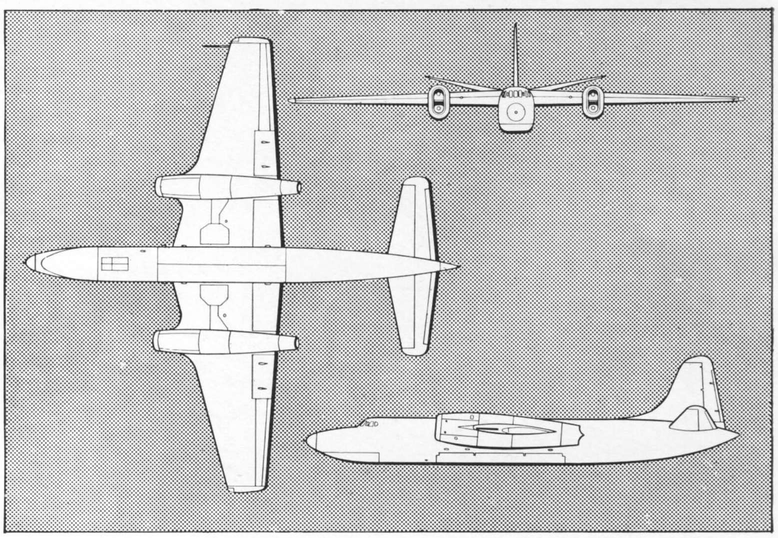


The Demon carrier-borne fighter was designed to meet U.S. Navy requirements for a single-seat fighter comparable in performance to the land-based fighters at that time being evaluated. Designed around the Westinghouse XJ40 turbojet, the prototype Demon, the XF3H–1, was flown on August 7, 1951, but was destroyed during initial testing. A second prototype, with redesigned and enlarged air intakes and an XJ40–WE–6 turbojet was flown.

Continual teething troubles with the Westinghouse engine led to the decision to abandon further development of the J40, and only sixty production F3H–1N Demon fighters use this power plant. With the sixty-first production machine the J40–WE–8 turbojet, of 7,500 lb. thrust, will be replaced by the 9,200 lb. thrust Allison J71–A–2 (F3H–2N). Variants include the F3H–2M missile launcher, the F3H–2P photo-reconnaissance variant, and the AH–1 attack fighter. The F3H–3 will have a 9,200 lb. thrust General Electric J73–GE–3 unit. Orders for 528 Demons were cut back to 280 machines in October 1954.

The Demon is characterised by its extremely high ratio of fuselage length to wing span. The wing, swept at some 40° at the leading-edge, carries power-actuated slats and trailing-edge slotted flaps. The jet pipe is cut back beneath the tail unit to reduce thrust losses, giving an unusual sawn-off appearance to the rear fuselage. The F3H–1N weighs 23,400 lb. in normal loaded condition and dimensions are: span, 35 ft. 4 in.; length, 58 ft. 4 in.; height, 13 ft. 11 in. Top speed is 758 m.p.h.; initial climb rate, 12,000 ft./min.; and range, 2,000 miles.

SHORT S.A.4 SPERRIN (AUGUST) 1951



Built to meet specification B.14/46 calling for a five-seat multi-jet long-range medium bomber of relatively orthodox layout and high-performance characteristics, the S.A.4 laboured under a disadvantage in so far as speed was concerned compared with swept-wing bombers developed to meet later specifications, and no production orders were placed.

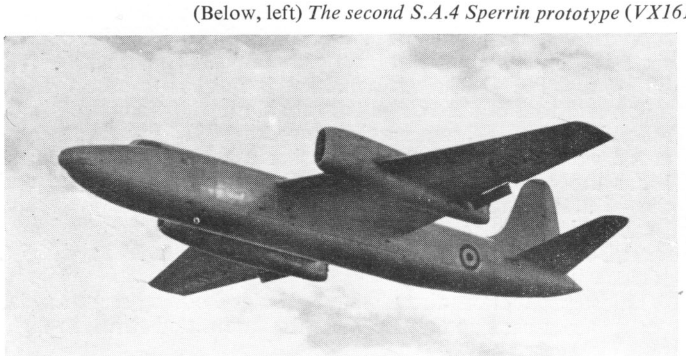
The most notable feature of the S.A.4's design was the disposition of the four turbojets, one superimposed upon another in two paired nacelles mounted centrally on the shoulder-positioned wing. An interesting feature of the controls was the use of full-span servo tabs on ailerons and elevators. The first of two S.A.4 experimental bombers flew on August 10, 1951, powered by four 6,500 lb. thrust Rolls-Royce Avon R.A.3 turbojets, and the second machine flew a year later, on August 12, 1952, powered by four 7,500 lb. thrust Avon R.A.7 units.

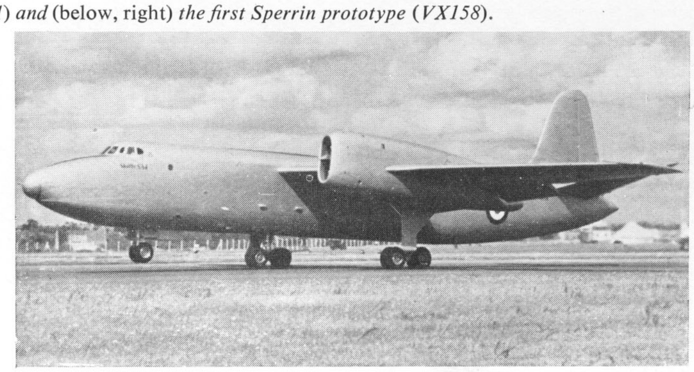
The Sperrin carried a maximum bomb load of 20,000 lb. and weighed 115,000 lb. With an internal fuel capacity of 6,060 Imp. gal. and a bomb load of 10,000 lb., range was 3,860 mls. and maximum speed was 564 m.p.h. at 15,000 ft. Design limiting Mach number was 0.85.

Both S.A.4 prototypes have been employed for high-speed and high-altitude bomber research and engine testing by the Ministry of Supply research establishments, and the first prototype is currently being employed as a flight test-bed for the de Havilland H-4 Gyron turbojet.

The S.A.4 carries a crew of five in a pressurised nose section, and dimensions are: span, 109 ft.; length, 102 ft. $2\frac{1}{2}$ in.; height, 28 ft. 6 in.; wing area, 1,896·7 sq. ft.

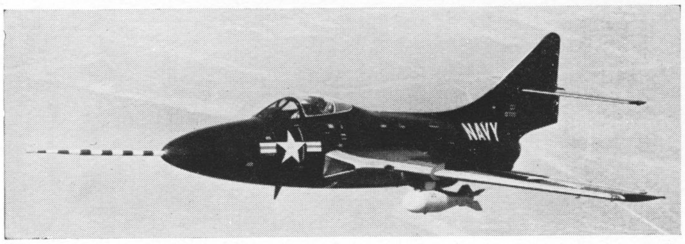
(Below, left) *The second S.A.4 Sperrin prototype* (*VX161*) *and* (below, right) *the first Sperrin prototype* (*VX158*).





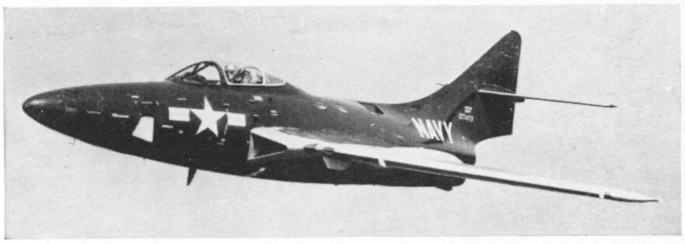
GRUMMAN (Model G-93) F9F COUGAR

(SEPTEMBER) 1951



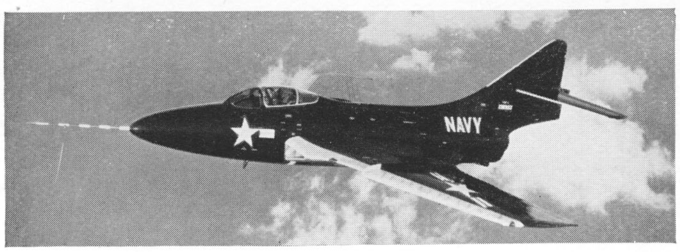
(Above) *F9F–6 Cougar (127219) with underwing bomb load.*

(Above) *Three F9F–6s which flew non-stop across the U.S.A.*

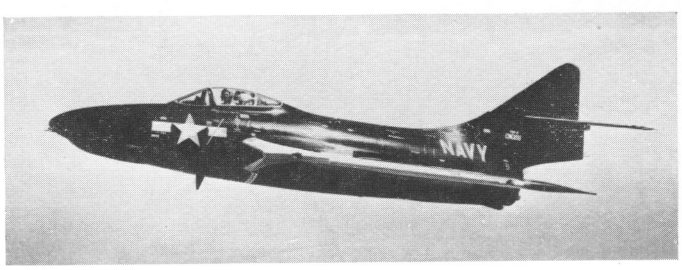


(Above) *The photo-reconnaissance F9F–6P Cougar (127473).*

(Above) *The J33-powered F9F–7 Cougar (130761).*



(Above) *F9F–8 Cougar (131063) and* (below) *F9F–8 (131069) with undernose radar housing.*



The Grumman Model G–93 Cougar was the first swept-wing ship-board fighter to enter service. Initially the requirements for carrier operation and the effects of wing sweep appeared incompatible as the necessary approach speeds of less than 115 m.p.h. could not be obtained with a highly loaded, swept wing. Additionally, sweepback increases dihedral effect, decreases the damping in roll and adversely affects the relationship between adverse yaw due to rolling and the stability of the aircraft.

The Grumman Cougar was a logical development of the earlier Model G–79 Panther, being virtually the marriage of the earlier fighter's fuselage to new wing and tail surfaces. The problem of approach speeds had been solved in the Panther by the use of leading-edge slats, operating in conjunction with conventional trailing-edge flaps, to increase the lift of the low-drag profile wing. This arrangement was retained on the Cougar, but trailing-edge flap area was increased by the extension of the flaps along three-quarters of the wing span. The leading-edge slats were increased in chord, and wing fences added to reduce spanwise flow. The stability problem of the 35° swept wing was solved by dispensing with ailerons and replacing them with spoiler panels on the upper-wing surface.

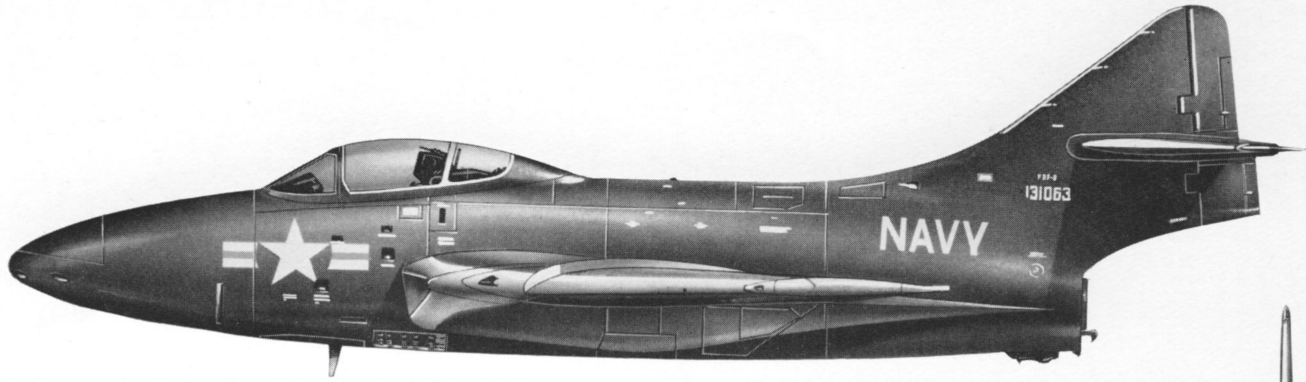
Detail design work on the Cougar commenced late in 1950, and the first prototype, the XF9F–6, which made use of a modified F9F–5 Panther fuselage and was powered by a 6,250 lb. thrust Pratt and Whitney J48–P–6A turbojet, flew on September 20, 1951. The first machine of the initial F9F–6 Cougar production batch was delivered to the U.S. Navy for evaluation less than five months later.

Like the earlier Panther, the fuselage of the Cougar is of excellent aerodynamic shape and of circular cross-section. The power plant arrangement is identical to that of the Panther, but the J48–P–4 or –6A turbojet of 6,250 lb. thrust (7,000 lb. with water injection) installed in the F9F–5 was replaced by the J48–P–8 of 7,250 lb. thrust (and 8,500 lb. with water injection) in all but early production F9F–6 Cougar fighters. In order to provide two alternative sources of power-plant supply, another turbojet, the 6,350 lb. thrust (7,000 lb. with water injection) Allison J33–A–16A engine, can be installed. The Allison-powered Cougar is designated F9F–7 and, due to the overall similarity of installation dimensions of the alternative engines, there are no noticeable external differences between the two models. The F9F–6P is a high-speed photo-reconnaissance model with a re-designed nose housing trimetrogon and K–17 cameras.

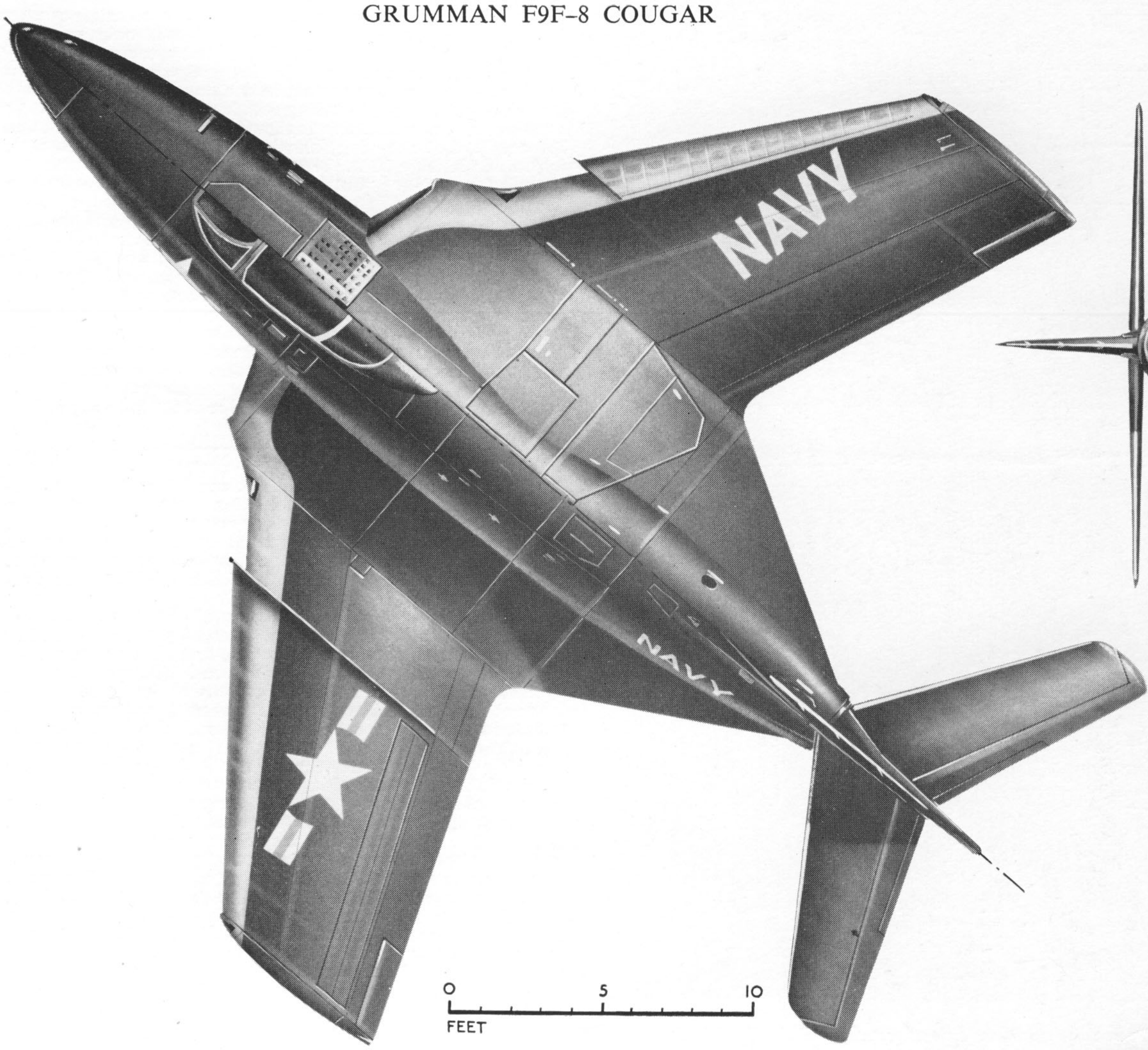
Progressive development of the Cougar has resulted in what is probably the final basic sub-type, the F9F–8, which flew for the first time on December 18, 1953. Embodying numerous refinements over its predecessors to increase its operational flexibility and improve its flying qualities, the F9F–8 features an 8-in. increase in the length of the fuselage centre section to allow for the installation of a larger fuel tank, the increase in capacity being 66·6 Imp. gal. The cockpit hood has been modified to improve rearward vision, but the most noticeable external changes are the provision of cambered leading-edge wing extensions and extended trailing edges. These changes increase the wing chord by 15 per cent and improve the limiting Mach number of the wing by providing a relatively thinner section. The leading-edge slats of earlier models have been deleted, providing space for an additional 25 Imp. gal. of fuel in each wing.

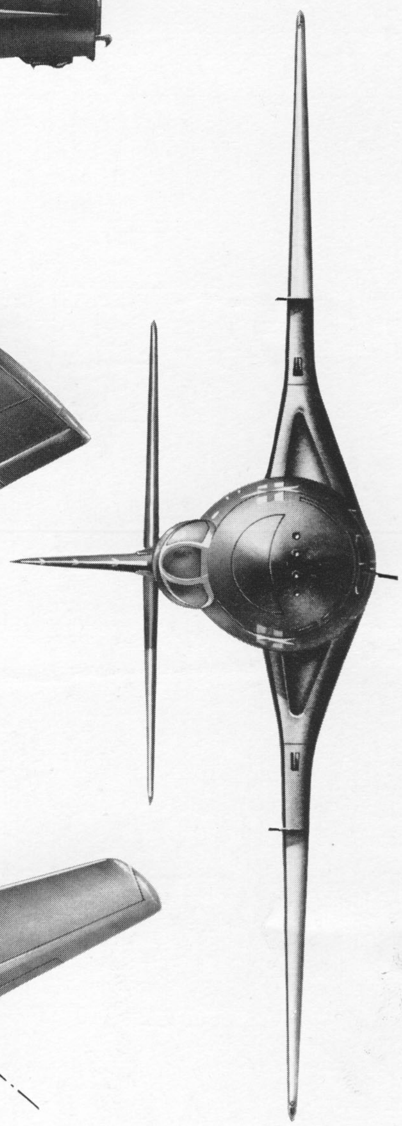
The Cougar has a fixed armament of four 20-mm. cannon installed in the fuselage nose and, when used in the tactical support role, carries an underwing load of two 1,000-lb. bombs, six 5-in. HVAR rockets or napalm tanks. The range of the F9F–6 and F9F–7 in clean condition is claimed to exceed 1,000 miles, and that of the F9F–8 is probably in the vicinity of 1,300 miles. The F9F–8 has a maximum speed of 714 m.p.h., as compared with 690 m.p.h. for the earlier models, and can exceed Mach unity in a shallow dive. Service ceiling is 50,000 ft., and the –6 and –7 models can attain 40,000 ft. altitude in 7 min. Loaded weight exceeds 20,000 lb.; and overall dimensions are: span, 34 ft. 6 in.; length, 40 ft. 2 in. (F9F–8) 40 ft. 10 in.; height, 15 ft.

Latest production aircraft have a bulge housing search radar under the nose, and some Cougars are fitted with in-flight refuelling gear.

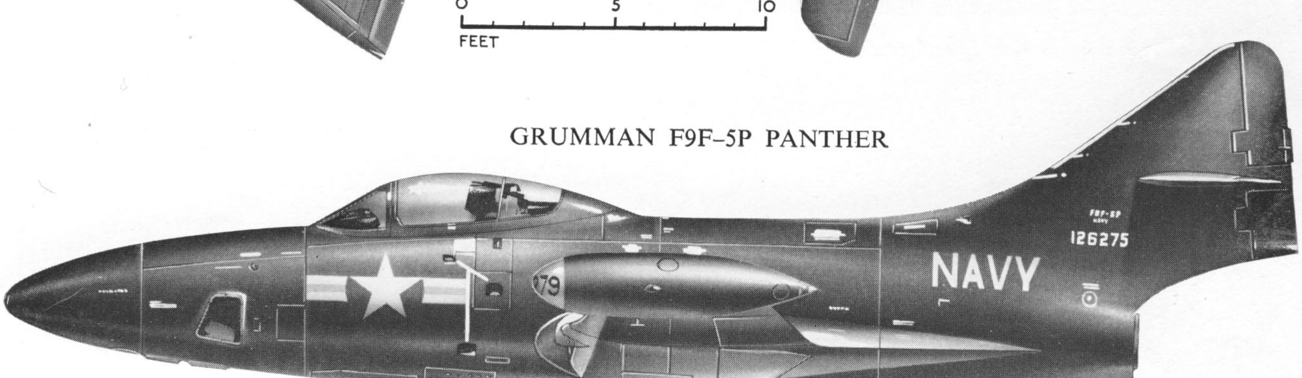


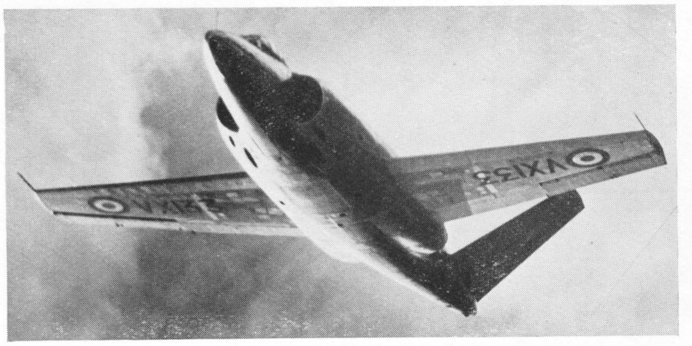
GRUMMAN F9F–8 COUGAR

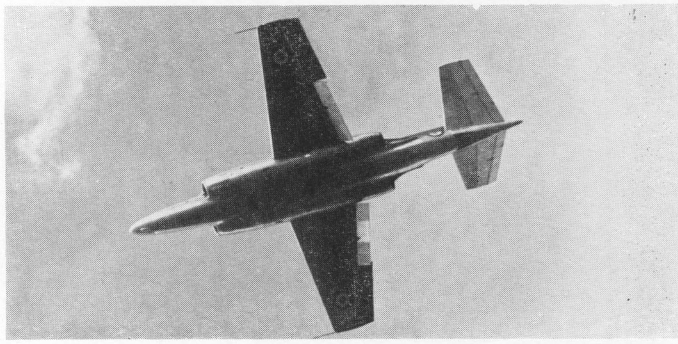




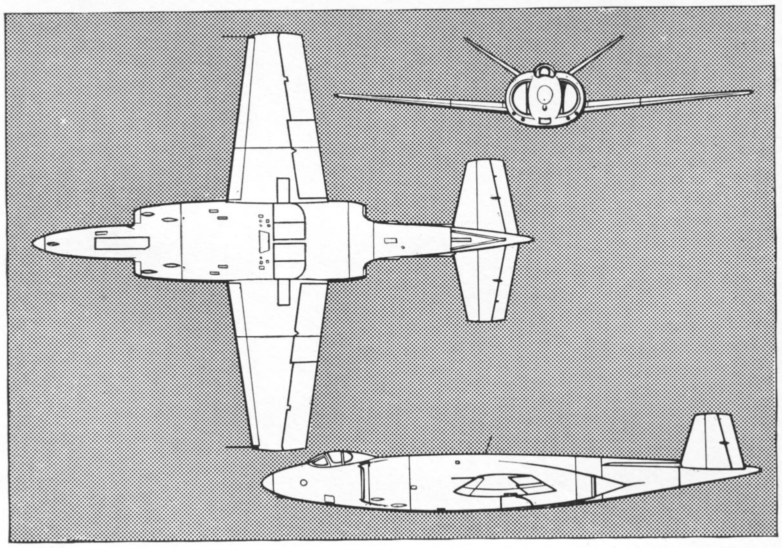
GRUMMAN F9F–5P PANTHER







(Above, left) *VX133, the experimental type 508 and* (above, right) *VX136, the experimental Type 529.*

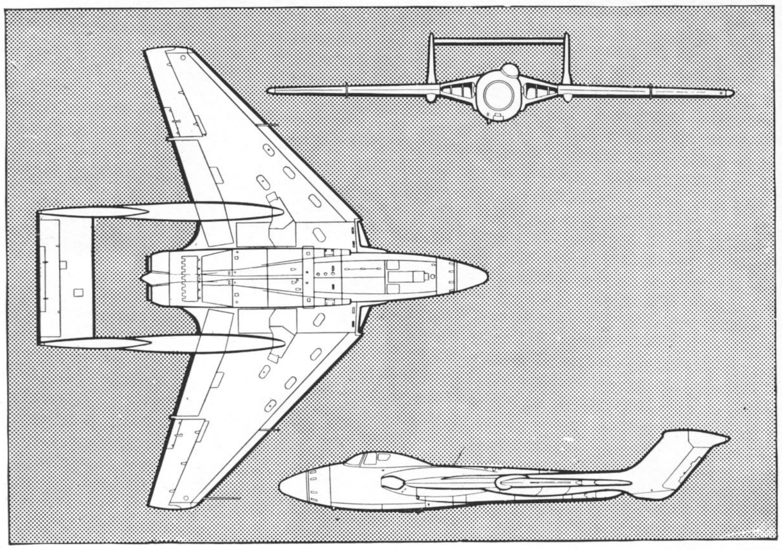


SUPERMARINE TYPE 508 (AUGUST) 1951

Developed as an experimental single-seat carrier-borne fighter to meet the requirements of a 1947 Naval specification, and embodying several novel features, the Supermarine Type 508, powered by two 6,500 lb. thrust Rolls Royce Avon R.A.3 turbojets, was undoubtedly the most powerful single-seat fighter extant when it first flew on August 31, 1951. The Type 508 was followed on August 29, 1952, by a similarly powered second machine, the Type 529, which differed only in detail.

The Types 508 and 529 were of singular appearance, employing extremely thin, short-span (41 ft.) wings carrying drooping leading edges which, operating in conjunction with very large trailing-edge flaps, kept landing speeds within carrier operating requirements, despite high wing loading. Gross wing area was 340 sq. ft., and the wing folded upward for carrier stowage, folded width being 20 ft. The most striking feature of the two aircraft was their "butterfly"-type tail assemblies which carried hinged trailing-edge portions operating together as elevators and differentially as rudders. These tail surfaces were attached to a tail cone which swivelled as a whole over a limited arc to give variable incidence. Height was 11 ft. 7½ in.

The large fuselage had a length of 50 ft., and the Avon turbojets were housed in the bulged centre fuselage, being fed via direct-air flank intakes and exhausting aft of the wing trailing-edge via short tailpipes. This feature reduced duct losses to a minimum and enabled a considerable proportion of the fuselage to be utilised for fuel tanks. An armament of four 30-mm. Aden guns was carried under the air intakes. Further development of the Types 508 and 529 resulted in the Type 525.



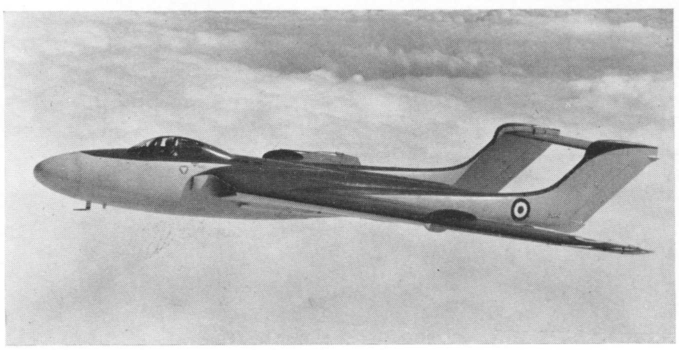
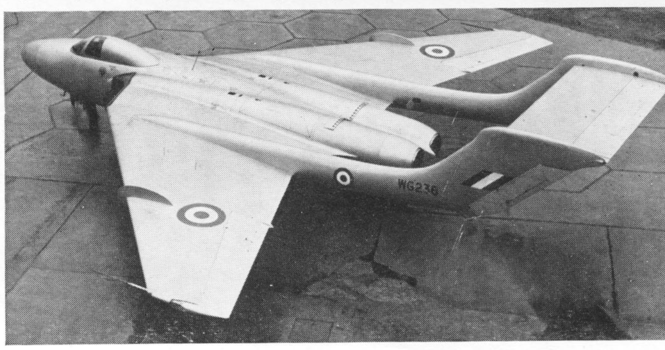
DE HAVILLAND D.H.110 (SEPTEMBER) 1951

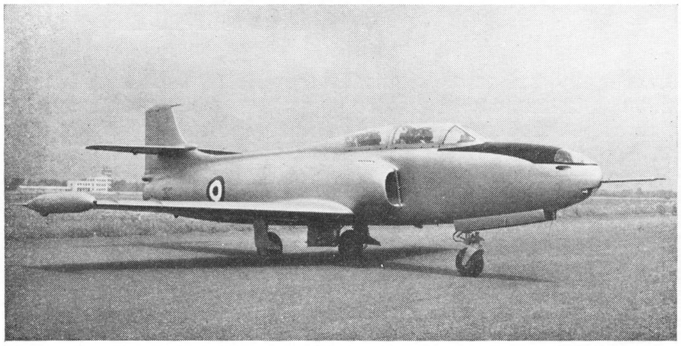
Originally designed to meet R.A.F. requirements for a two-seat all-weather fighter, the D.H.110 achieved the distinction of being the first two-seat aircraft to exceed Mach 1·0, making its first supersonic flight on April 9, 1952. Powered by two 7,500 lb. thrust Rolls-Royce Avon turbojets, the first prototype D.H.110 flew on September 26, 1951, being followed on July 25, 1952, by a second prototype.

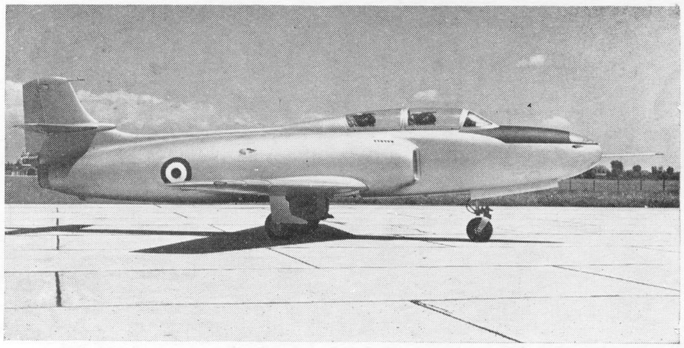
Currently under development as an all-weather fighter and strike aircraft for the Royal Navy, the third prototype D.H.110 has been adapted for deck operation, featuring arrester gear, wing folding and other naval equipment. The second prototype has received several modifications to improve its performance and suitability for carrier operation since its initial flight-test phase. An all-moving horizontal tail surface has been fitted for improved control at supersonic speeds, a drooping leading-edge has been fitted to the wing to enable the aircraft to take off with greater loads and to improve the landing characteristics, and the original Avon turbojets have been supplanted by 9,500 lb. thrust Avon R.A.14 units.

The D.H.110 is one of the very few modern jet combat aircraft to embody the twin-tailboom configuration. The broad-chord wing is swept 45° at the leading edge and has a span of 51 ft. Despite the D.H.110's loaded weight of some 30,000 lb., the large wing area results in a relatively low wing loading. The overall length of the D.H.110 is 52 ft. 1½ in., the pilot's cockpit is offset to port in the fuselage nacelle, and the radar operator is seated below and to the rear of the pilot on the starboard side.

(Below, left) *The semi-navalised second prototype D.H.110 (WG240) and* (below, right) *the first prototype D.H.110 (WG236).*





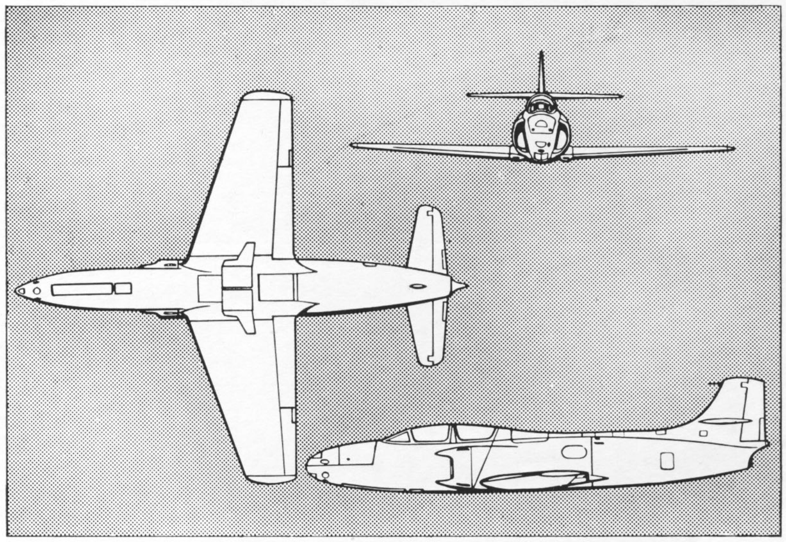
(Above, left) *The Nene-powered Fiat G.82.* (Above, right) *The Goblin-powered G.80–3B and* (drawing) *G.80–1B.*

FIAT G.80 (DECEMBER) 1951

The first Italian jet aircraft of postwar design, the Fiat G.80 was designed to meet very similar requirements to those for which the Fokker S.14 had been produced but differed in conception in providing tandem seating for the pupil and instructor, the G.80's designer, Giuseppe Gabrielli, considering this arrangement to be more logical for the training of a pilot who will proceed to a single-seat fighter.

Of conventional layout and construction, the G.80 flew for the first time on December 9, 1951, powered by a 3,500 lb. thrust de Havilland Goblin 35 turbojet, and was followed by two similarly powered production prototypes, the G.80-1B and the G.80-3B—the latter being intended for armament training—and a variant powered by a 5,000 lb. thrust Rolls-Royce Nene 2-21 and designated G.82. Projected variants with alternative power plants include the G.81, powered by a 4,850 lb. thrust Fiat-built Ghost 48, and the G.84, powered by a 5,400 lb. thrust Allison J35-A-29.

The G.80 series are primarily intended for the training role, but single-seat versions of each sub-type can be produced for the all-weather-fighting and close-support roles. The G.80-3B and G.82 have the following weights and performances (figures for the latter version are quoted in parentheses) : weight empty, 8,700 (9,724) lb., loaded, 12,786 (13,483) lb.; maximum speed, 522 (578) m.p.h. at 4,280 ft.; initial climb rate, (5,510) ft./min.; range with internal fuel only, 683 (620) miles at 360 (339) m.p.h. at 34,800 ft. Overall dimensions are : span, 38 ft. 1 in.; length, 42 ft. 5 in. ; height, 13 ft. 4 in.; wing area, 270·6 sq. ft.



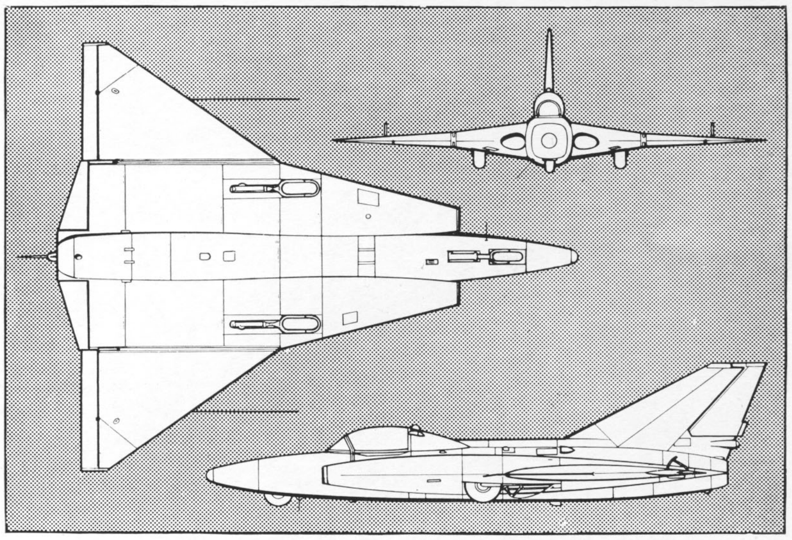
SAAB–210 DRAKEN (DECEMBER) 1951

Built expressly to furnish data on the low-speed characteristics of the unusual "double delta" planform, the SAAB-210 Draken (Kite) was powered by a 1,050 lb. thrust Armstrong Siddeley Adder A.S.A.1 turbojet, and was first flown in December 1951.

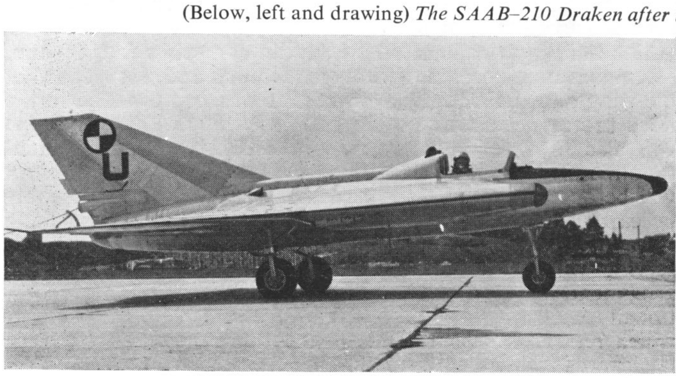
The salient features of the Draken are the remarkably low aspect ratio and entirely new planform of its 16-ft.-span wing. Described as "double delta", the wing planform comprises two distinct triangles. The inboard wing sections have a leading-edge sweep of some 70° and the outboard sections are swept 50°. This compound sweep has the advantage of keeping the thickness ratio low on the inboard sections which, in the full-scale wing, will house the turbojets, fuel and other equipment. This wing is actually a half-scale model of that to be employed by the SAAB-35 all-weather fighter, the Rolls-Royce Avon turbojets of which will be housed in the thickened wing roots. The reduced sweep on the outboard sections presumably has a favourable effect on tip stalling at low speeds.

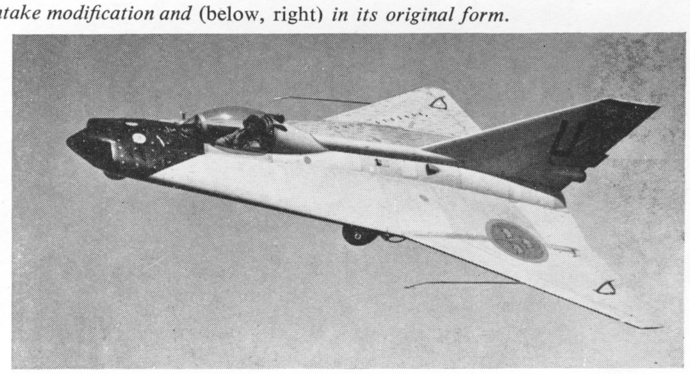
The Draken is fitted with a wide range of measuring equipment and, despite the small size of its cockpit, carries an ejector seat for the pilot. The main members of the retractable nosewheel undercarriage may be moved forward or backward to change the ground angle, and the c.g. can be changed in flight by pumping liquid between trim tanks in the nose and tail of the 20-ft. fuselage. In its initial form the Draken's air intakes were positioned close to the fuselage nose, but these were later cut back to line with the pilot's windscreen.

Despite its low power, the Draken has attained speeds in excess of 400 m.p.h. during its extensive flight-test programme.



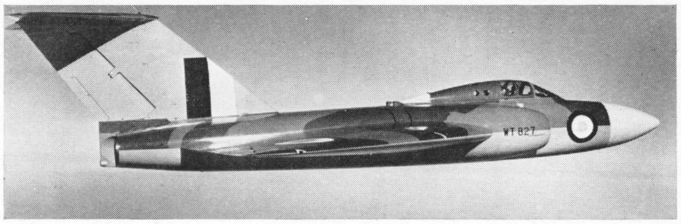
(Below, left and drawing) *The SAAB–210 Draken after intake modification and* (below, right) *in its original form.*

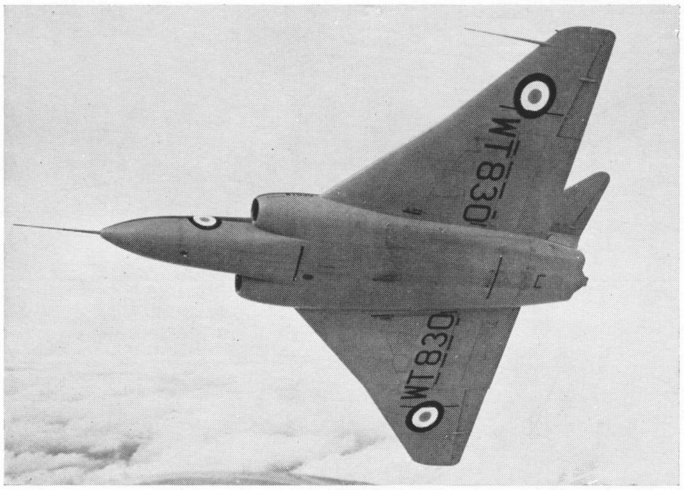




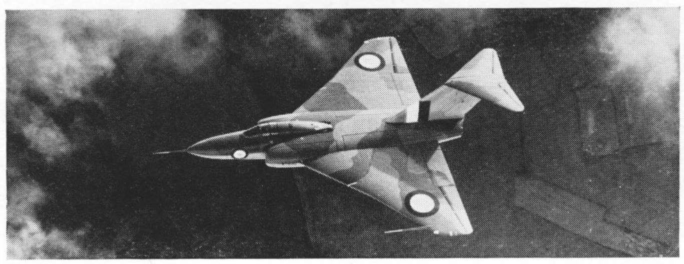
GLOSTER JAVELIN F.(A.W.)1 (NOVEMBER) 1951

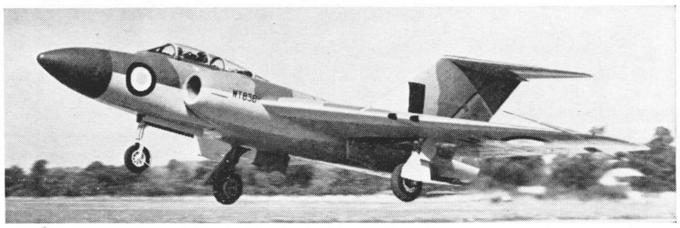
(Above) *First prototype, WD804, and* (below) *third prototype, WT827.*



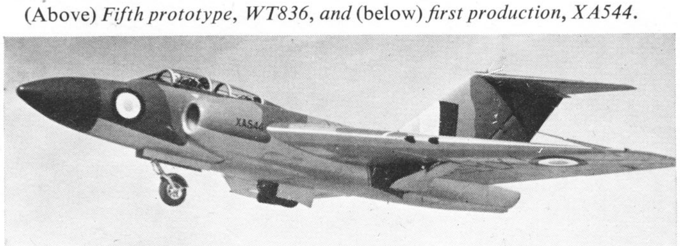


(Above and below) *Fourth prototype, WT830, with revised wing.*





(Above) *Fifth prototype, WT836, and* (below) *first production, XA544.*



Structurally and aerodynamically the Gloster Javelin night and all-weather interceptor fighter is perhaps the most impressive aircraft yet produced to fulfil this role. Flown for the first time on November 26, 1951, and characterised by its relatively thick delta wing and large vertical tail surfaces surmounted by a triangular tailplane, the Javelin possesses the dual distinction of being the world's first twin-jet aircraft of delta planform, and the first British jet aircraft to be designed from the outset for the all-weather-fighter role to enter production.

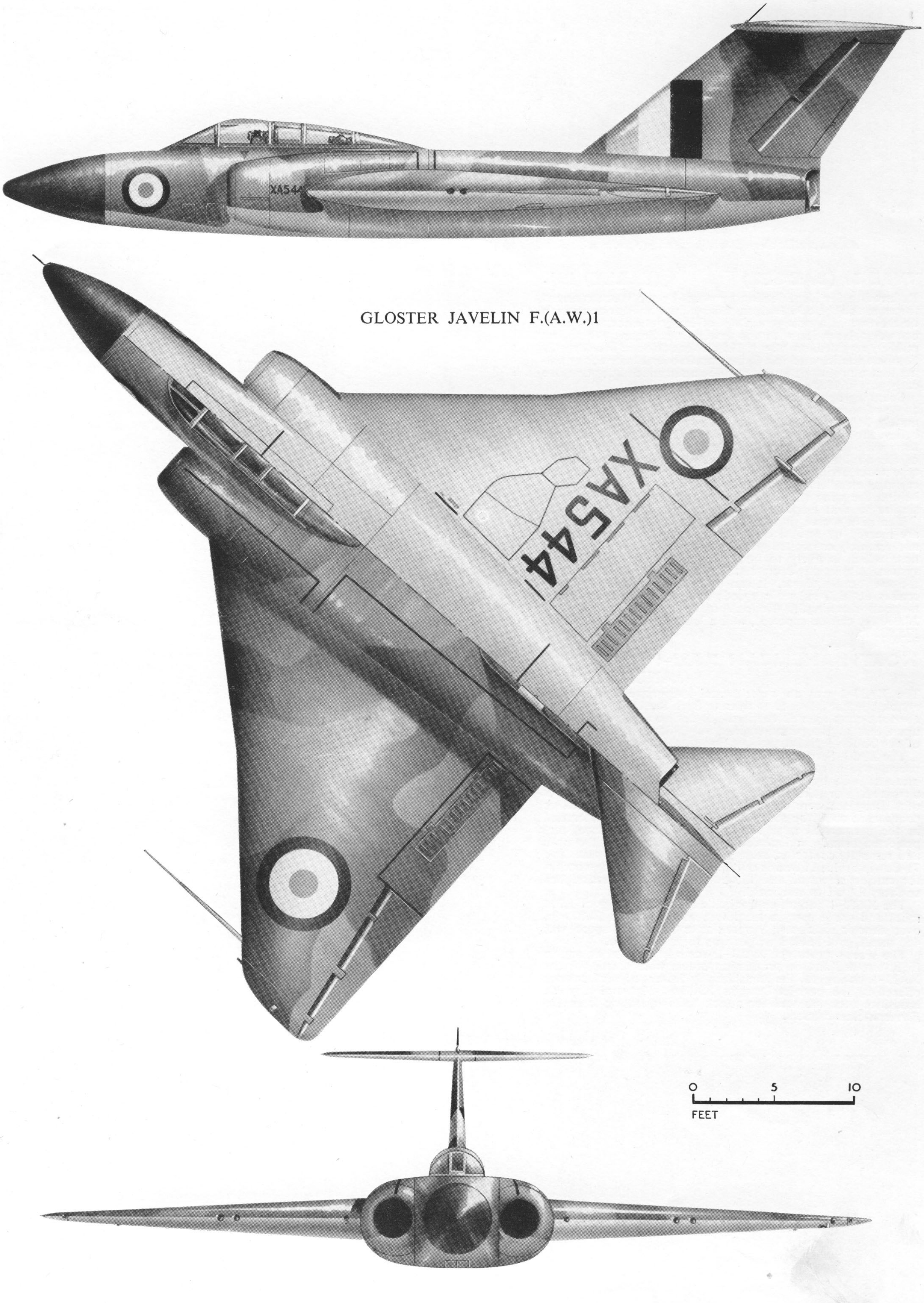
The Javelin is an excellent example of the use of the wing envelope to house fuel tanks, undercarriage wells and armament, the root chord being so great that the low relative thickness provides a large physical depth. Loaded weight is relatively high, being reported as between 30,000 and 35,000 lb., but the generous area of the 52-ft.-span wing (some 900 sq. ft.) confers a comparatively low wing loading—between 33 and 39 lb./sq. ft.—which undoubtedly contributes to the Javelin's impressive take-off, climb and landing performance. The wing leading-edge sweep angle is 39°. This angle was continuous on the first three prototypes, but the second prototype was subsequently modified to have reduced sweep on the outer panels, increasing the chord at the tips and giving a better fineness ratio over the ailerons. The second prototype was first flown with the modified wing on May 28, 1953, and the fourth prototype, which flew on January 14, 1954, and subsequent Javelins adopted the new wing planform as standard.

A distinctive feature of the Javelin is the use of a tailplane which makes practicable the use of flaps to reduce take-off and landing speeds and the high-incidence landing angles common to tailless deltas—factors of considerable importance on night operations. The tailplane, which, being movable in conjunction with the elevators, also ensures good manœuvrability at all speeds and altitudes and is useful to trim out Mach effects. Air brakes are disposed above and below the wing. The fuselage has a length of 57 ft., and overall height is 16 ft. 3 in. The pilot and radar operator are seated in tandem ejector seats under a continuous canopy which was first introduced on the fifth prototype. The canopy comprises two separate sliding sections with a fixed bridge, each section being fully transparent.

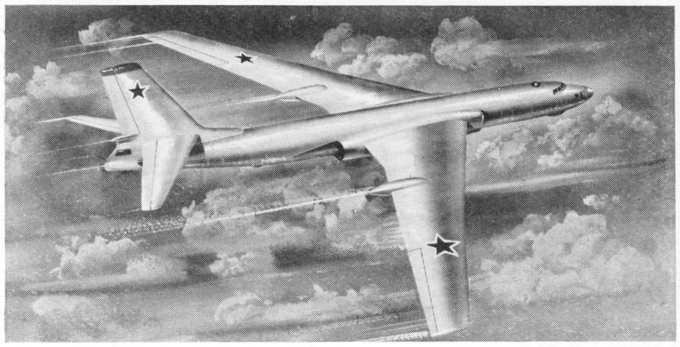
The Javelin is powered by two Armstrong Siddeley Sapphire turbojets disposed in nacelles at the fuselage sides and exhausting via side-by-side ducts in the rear fuselage. This location would seem favourable for the fitment of afterburners, and the close proximity of the thrust lines to the fuselage centre line should enable the Javelin to cruise on the power of one engine without any appreciable asymmetric forces. While prototypes and initial production machines are powered by 8,000 lb. thrust Armstrong Siddeley Sapphire A.S.Sa.6 turbojets, later production Javelins are likely to have the 10,200 lb. thrust Sapphire A.S.Sa.7 or later variants of this turbojet with even greater thrust ratings.

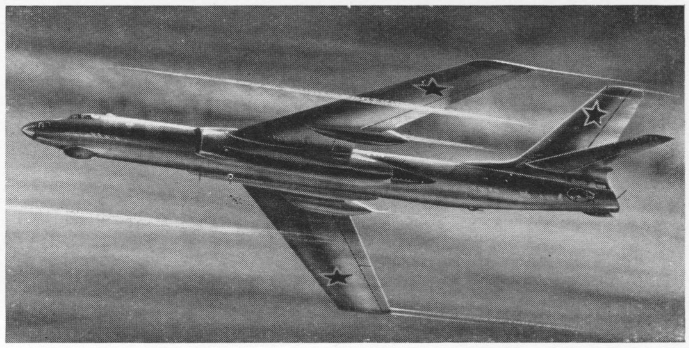
No details are available regarding the fuel tankage of the Javelin, but it is to be presumed that endurance is comparable to that of any all-weather fighter extant. Large-capacity tanks are enclosed in both the wing and fuselage, and two flush-fitting slipper-type tanks can be fitted side by side under the fuselage, or one very large ventral tank—likely to have a capacity of the order of 1,000 Imp. gal.—can be carried. Official announcements have suggested that the Javelin can exceed Mach unity in level flight at 50,000 ft., and the prototypes have repeatedly exceeded Mach 1·0 at lower altitudes in shallow dives. Airframe limiting Mach number presumably exceeds 1·2 and the Javelin will be capable of taking advantage of the higher thrust-ratings provided by later Sapphire turbojets.

The built-in armament of the Javelin comprises four 30-mm. Aden guns mounted well back from the ports and just inboard of the wing outer panels. This armament was first installed in the third prototype which flew on March 7, 1953. This prototype was also used for comparative trials with blunt and pointed radomes. It has been officially stated that the cannon armament will be augmented by air-to-air missiles which will presumably be carried in underwing pods or a retractable belly launching tray. The Javelin is likely to be the first operational aircraft serving with the R.A.F. to include air-to-air missiles in its armament. Another notable feature of the Javelin is the exceptionally wide track of its undercarriage, the main members of which retract inwards into the wings, the nosewheel retracting backwards into a well in the fuselage nose.



GLOSTER JAVELIN F.(A.W.)1





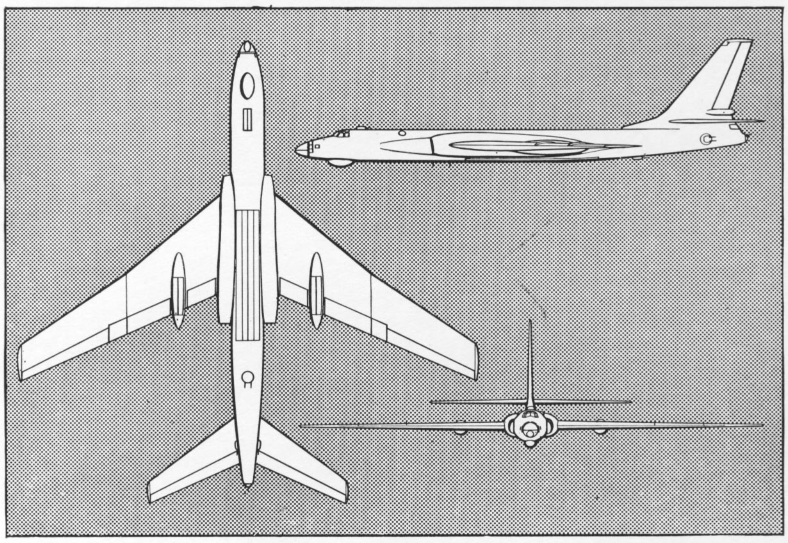
A medium bomber currently entering service with Russia's strategic bombing arm, the Type 39 Badger has two unusually large turbojets.

TYPE 39 (BADGER) (EARLY) 1952

Referred to for identification purposes by the Western armed forces as the Type 39 Badger, this medium bomber appears to be the first of a new generation of large jet aircraft to enter operational service with the Soviet Air Force. When first publicly revealed, on May 1, 1954, a formation of *nine* Type 39 bombers participated in a flying parade over Moscow, suggesting that a prototype must have flown not much later than the early part of 1952.

Spanning approximately 100 ft., the wing has a sweepback angle of some 40° at the leading edge, reducing to approximately 34° on the outboard sections. Two large turbojets, believed to afford a total thrust of some 30,000 lb., are mounted flush with the fuselage sides. The fuselage is flattened ahead of the air intakes in order to improve flow. A nosewheel-type undercarriage is fitted and the twin bogie-type main undercarriage members retract backwards into prominent fairings behind the wing trailing edge—this unusual geometry being similar to that employed by the experimental Valiant B.2.

The pilot's cockpit is stepped, and the fuselage contours are marred by several dorsal and ventral sighting positions and remotely controlled guns, and by a large bulge under the nose which is likely to house a radar bombing-navigation system. A manually operated tail gun position is installed aft of the swept-tail surfaces. It can be assumed that the Type 39 cruises at high subsonic speeds and possesses a maximum range approaching 3,000 miles. A maximum bomb load of some 20,000 lb. can be expected, and a loaded weight of 150,000–175,000 lb.



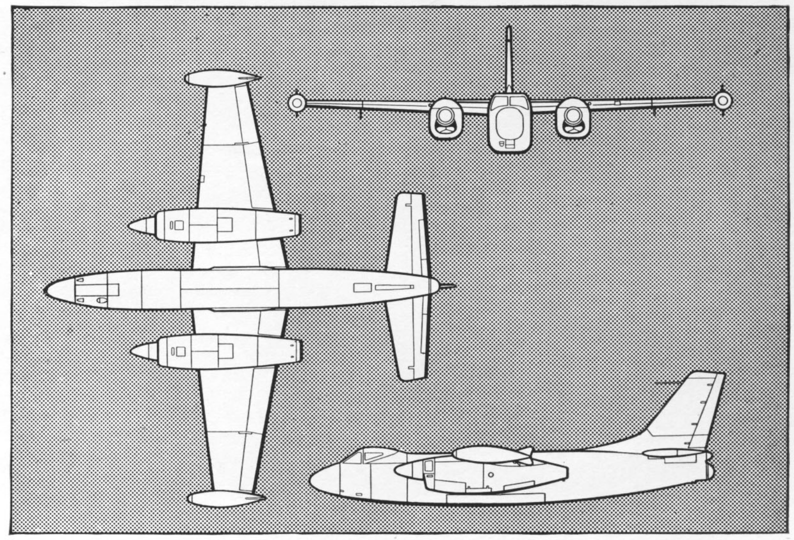
NORTH AMERICAN XA2J–1 (JANUARY) 1952

The XA2J–1 was an experimental long-range carrier-borne attack bomber intended to operate from the U.S. Navy's new *Forrestal*-class aircraft carriers. Its design was based largely upon that of the piston-engined AJ–2 Savage, and the first of two XA2J–1 prototypes was flown on January 4, 1952.

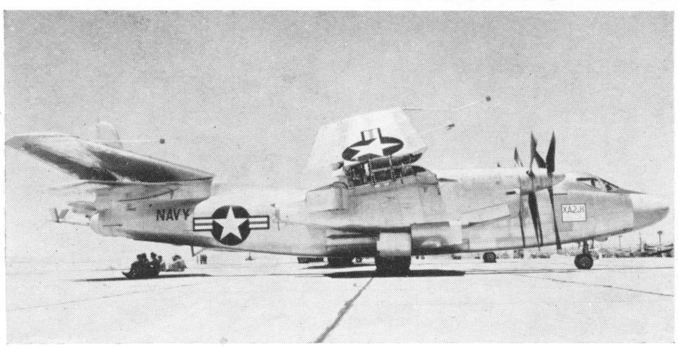
The XA2J–1 was powered by two Allison XT40–A–6 turboprops, which each comprised two T38–A power sections mounted side by side and driving six-blade contra-rotating airscrews. For take-off and combat power both components of the engines were employed, but for cruising flight either component could be stopped. A crew of three was carried in the pressurised nose section of the 62-ft. fuselage, and projected armament included two 20-mm. guns in the nose and remotely controlled rearward-firing guns in the tail. The 71-ft. wing folded inwards outboard of the turboprop nacelles for carrier stowage, and the 20-ft.-high swept vertical tail surfaces folded to starboard.

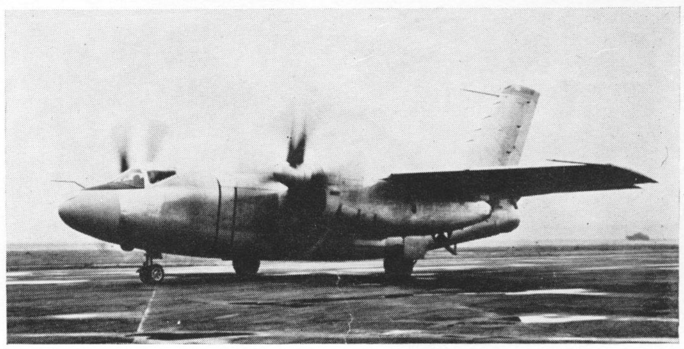
The XA2J–1 had an approximate maximum range of 1,700 miles and could carry a maximum bomb load of 10,000 lb. over shorter distances. Approximate maximum speed was 440 m.p.h. and loaded weight was some 58,000 lb.

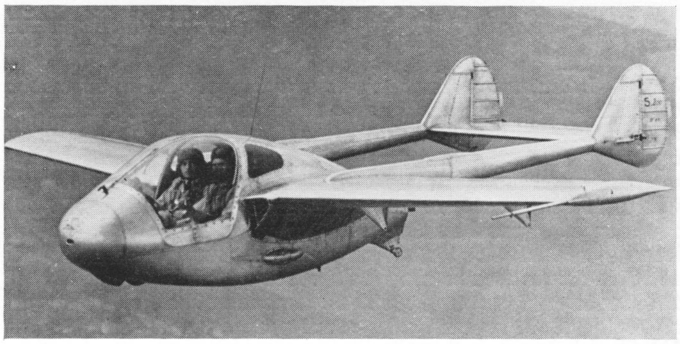
The second prototype XA2J–1 was later used as an engine flight test bed and no production orders were placed for the XA2J–1 owing to the considerably improved performance offered by the pure-jet Douglas XA3D–1 Skywarrior, which has since been adopted for attack units operating from the *Forrestal*-class carriers.

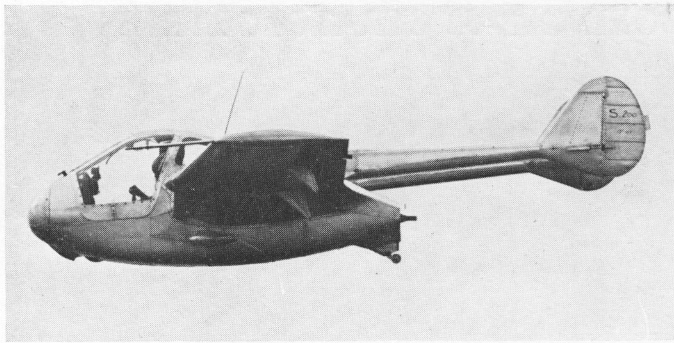


(Below, left) *Second prototype XA2J–1 and* (below, right) *first prototype.*









One of the first light jet aircraft, the Minijet was designed for both liaison and training roles. Photos depict the first Minijet prior to modifications seen in drawing.

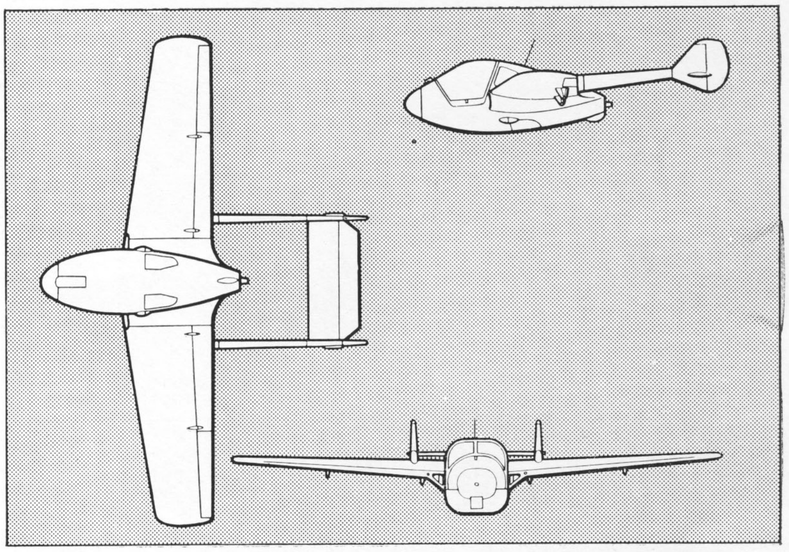
S.I.P.A.200 MINIJET (JANUARY) 1952

The S.I.P.A.200 Minijet was designed for the dual role of high-speed short-range liaison aircraft and economical transitional trainer. Work on the Minijet was initiated in February 1951, and the first of two prototypes was flown on January 14, 1952. A pre-production batch of five Minijets has since been ordered, and a manufacturing licence has been obtained by the Dutch N. V. Koolhoven Vliegtuigen.

The Minijet is an all-metal twin-boom mid-wing monoplane with an hydraulically retractable nosewheel undercarriage and a 330 lb. thrust Turboméca Palas turbojet in the rear of the central fuselage nacelle. The laminar-flow wing has double-slotted Fowler-type trailing-edge flaps and aerodynamically-balanced slotted ailerons.

The cabin in the central nacelle seats two side by side, the entire canopy hinging forward for access. A fireproof bulkhead in line with the wing rear spar separates the cabin from the engine bay, and the air intakes for the Palas turbojet are in the thickened wing roots. The second prototype has attachment points for wing-tip auxiliary tanks and is stressed for aerobatics as a trainer.

The Minijet has a maximum speed of 248 m.p.h. at sea level and cruises at 223 m.p.h. at 3,280 ft. Initial climb rate is 1,132 ft./min., ceiling is 26,240 ft., and range (without wing-tip tanks) is 350 miles. Empty and loaded weights are 990 lb. and 1,675 lb. respectively, and overall dimensions are: span, 26 ft. 2 in.; length, 17 ft.; height, 5 ft. 10 in.; wing area, 104 sq. ft.

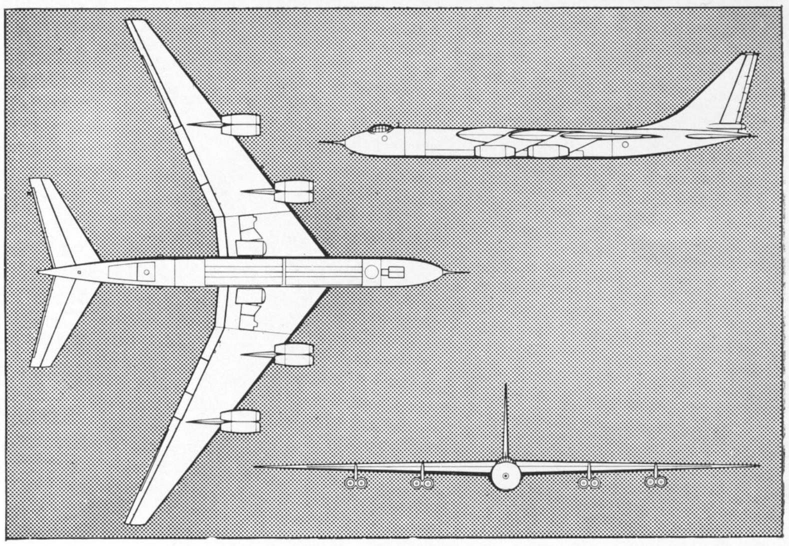


CONVAIR YB-60 (APRIL) 1952

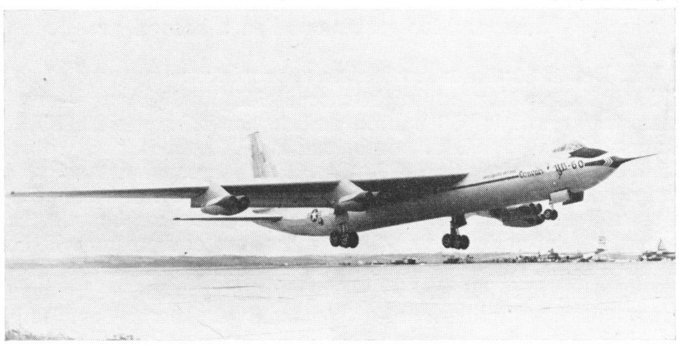
Developed to meet the same U.S.A.F. long-range heavy bomber requirements as those fulfilled by the Boeing B-52 Stratofortress, the YB-60 was derived from the piston-engine/turbojet B-36, and was initially known as the B-36G. Employing a large number of B-36 components and thus offering the possibility of using a considerable amount of existing tooling, the contract for two YB-60 experimental aircraft was awarded on March 15, 1951, and the first YB-60 flew on April 18, 1952.

The YB-60 was initially powered by eight Pratt & Whitney J57-P-3 turbojets, which were at that time rated at 8,800 lb. thrust each. However, it was proposed to install later J57 engines with five-figure thrust ratings, and with these a maximum speed of 550 m.p.h. at 55,000 ft. was anticipated. The YB-60's fuselage from aft of the cabin was identical with that of the B-36, as was also the centre portion of the wing centre section. The wing was swept some 35° at the leading edge, which reduced span from that of the B-36 to 206 ft. A new swept tail assembly was fitted, and the nose was modified. Overall length was 171 ft. and height was 50 ft. The eight turbojets were installed in four paired pods suspended below and forward of the wing leading-edge. The main undercarriage members and nosewheel assembly of the B-36 were retained, but a retractable tailwheel was added in the rear fuselage.

The YB-60 had an approximate maximum loaded weight of some 380,000 lb. and a maximum range of 8,000 miles, and extensive trials were undertaken with the two prototypes. However, no production orders were placed by the U.S.A.F. as the B-52 had been chosen to fulfil the heavy-bomber role.

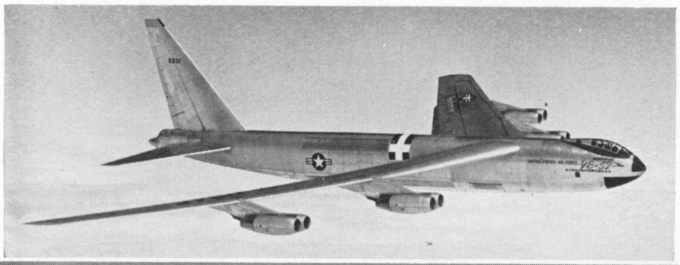


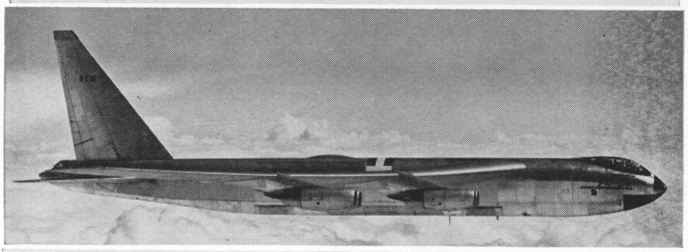
The experimental YB–60 bomber employed many components of the piston-engined B–36 heavy bomber.

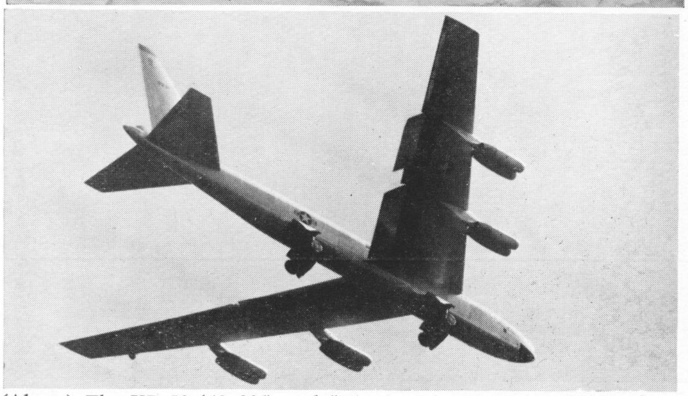


BOEING B–52 STRATOFORTRESS

(APRIL) 1952

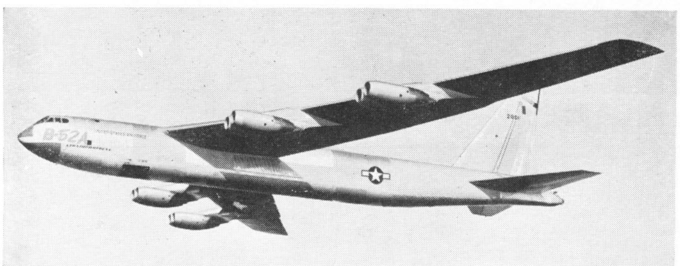






(Above) *The YB–52 (49–231) and* (below) *with XB–52 (49–230) in foreground.*

(Below) *The first B–52A Stratofortress (52–001).*



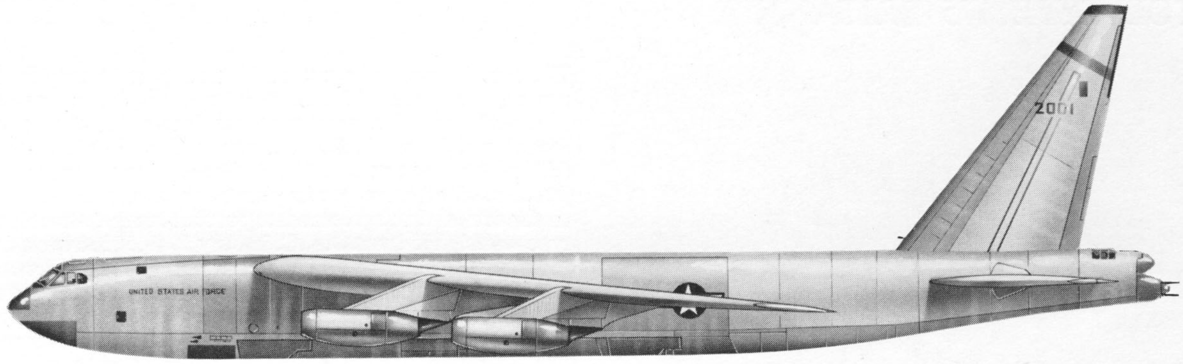
The B–52 Stratofortress represents a logical scaling-up of the earlier B–47 Stratojet medium-bomber, its most notable features being a heavily loaded extremely flexible wing and an unorthodox control system. Development of the Stratofortress was commenced in the summer of 1946, and an order for two prototypes was placed in September 1947. The first prototype, the XB–52, commenced ground testing on November 29, 1951, and was joined on March 15, 1952, by the second prototype, the YB–52. The XB–52 was then returned to the factory for the installation of additional equipment, the YB–52 becoming the first to fly on April 15, 1952, reversing the usual procedure, the XB–52 not flying until October 2, 1952. The prototypes were powered by eight Pratt and Whitney J57–P–1 turbojets each rated at 8,700 lb. thrust, and differed from production models which have a completely redesigned nose and crew compartment with side by side seating for the pilot and co-pilot in place of the tandem seating featured by the prototypes.

The narrow-chord wing of the Stratofortress is swept at an angle of 35° and is mass-balanced by the forward-projecting turbojet pods. Spanning 185 ft. and having a gross area of 4,000 sq. ft., the wing is extremely flexible and the ground anhedral angle of several degrees is eliminated in flight, the outboard panels taking on noticeable dihedral. Primary bending loads, other than those absorbed by the heavy-gauge skin, are taken by the massive main spar which, at 50 per cent chord, stretches unbroken to the tip. Wing loading exceeds 87·5 lb./sq. ft. The straight-taper swept wing is subject to loss of incidence at the tips as it flexes, giving rise to aileron reversal. To overcome this tendency, the Stratofortress wing dispenses with normal ailerons, employing small inboard ailerons with three-piece spoilers at mid-span. Should one of the outboard turbojets fail, the yawing moment is countered by the spoilers which destroy lift and increase drag. Flaps of modified Fowler-type are fitted to the trailing edge.

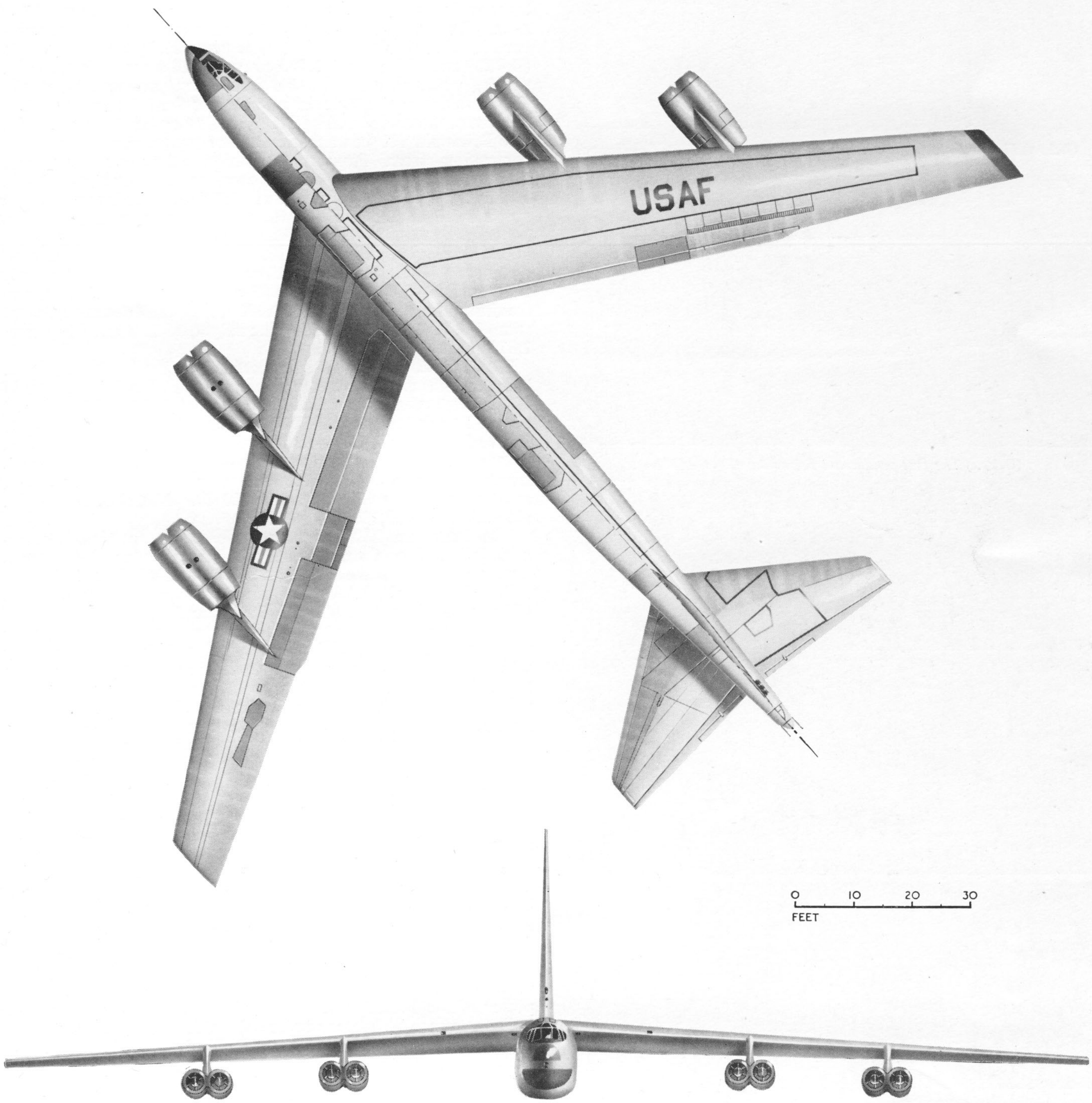
The fuselage has a length of 156 ft. 6 in., and only the cockpit and tail gunner's compartment are pressurised. The Stratofortress carries a crew of five or six, according to the mission it is to perform, and pilot and co-pilot are seated side by side. Defensive armament comprises four 0·5-in. guns in a tail position which can be manually or radar-directed. The undercarriage geometry is unusual, comprising quadruple mainwheels arranged in tandem pairs and small outrigger wheels for lateral balance. The latter do not normally come into contact with the ground. The main wheels retract fore and aft of the bomb-bay, the port units retracting inwards and forwards and the starboard units inwards and to the rear. The vertical fin, which folds to simplify ground handling, is of exceptional size, and the rudder is disproportionately small. Overall height is 48 ft. 3½ in.

An initial production order for thirty-six Stratofortresses was placed in 1951, the first B–52A production model flying on August 5, 1954. Considerable additional production orders have since been placed for the U.S.A.F.'s Strategic Air Command. The B–52A is powered by eight 9,700 lb. thrust Pratt and Whitney J57–P–3 turbojets, but only three aircraft of this model were produced, the first major production model being the B–52B, which features minor refinements. The B–52B can have two interchangeable types of pressurised pods which fit into the bomb-bay. One pod will carry aerial cameras and two operators, and the other will be for electronic countermeasures and will house a crew of six and equipment. Further production variants include the B–52C and B–52D, which will have J57 turbojets of higher thrust ratings such as the 10,900 lb. thrust J57–P–15. The first production line for the B–52B Stratofortress was established at Boeing's Seattle division and, in 1953, Boeing's Wichita division was named as a second production source.

The B–52B Stratofortress has an approximate empty weight of 175,000 lb., and loaded weight exceeds 350,000 lb. Approximate maximum speed is 630 m.p.h., and service ceiling is 50,000 ft. Range with a 75,000-lb. bomb load is 3,000 miles, and with a 25,000-lb. bomb load is 6,000 miles. For the reconnaissance role range exceeds 8,500 miles, and internal tankage can be supplemented by external fuel tanks attached to the wing beyond the outermost jet pods and in-flight refuelling equipment will be fitted as standard on all production Stratofortresses. The Stratofortress can be adapted for the FICON system, carrying a reconnaissance fighter semi-externally in the bomb-bay. This will be launched and retrieved while the bomber is in flight.

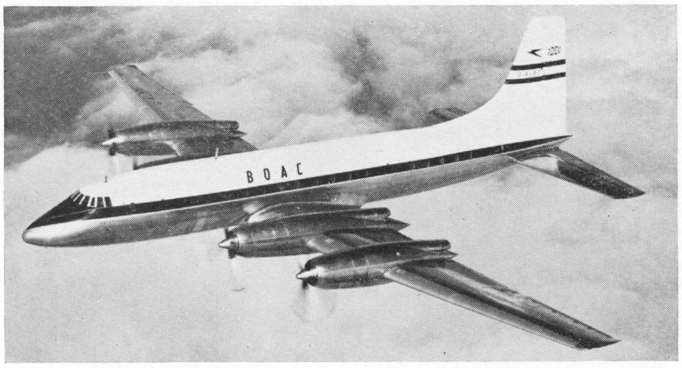


BOEING B–52A STRATOFORTRESS

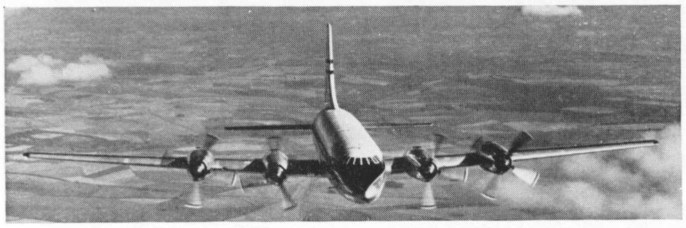


BRISTOL TYPE 175 BRITANNIA

(AUGUST) 1952

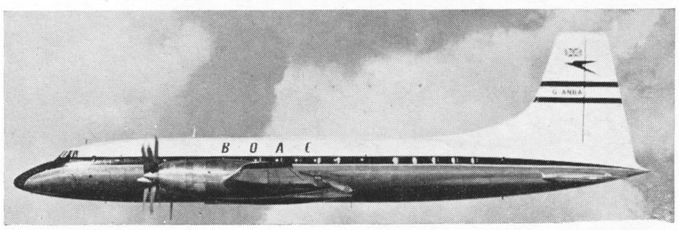


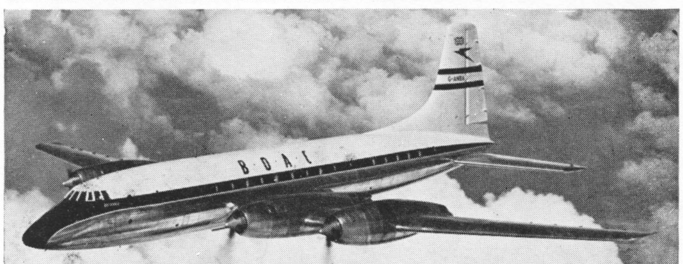
(Above and below) *The first prototype Britannia 100* (*G–ALBO*).



(Below) *First and second prototypes, the latter* (*G–ALRX*) *in foreground.*

(Below) *The first production Britannia 100* (*G–ANBA*).





The first long-range commercial transport to employ turboprop power, the Type 175 Britannia was originally envisaged as a thirty-two to fifty passenger medium-range transport with a loaded weight of 102,000 lb., powered by four Bristol Centaurus 663 piston engines. Bristol Proteus turboprops were projected as alternative power plants for later production Type 175 transports, and an agreement to purchase twenty-five aircraft of this type was signed by B.O.A.C. in July 1949. However, as development progressed, it was decided that all machines would be turboprop-powered, maximum payload being increased from 17,000 lb. to 25,000 lb., and estimated range with this payload from 2,650 miles to 4,000 miles. Basically a low-wing cantilever monoplane, the Britannia has an all-metal two-spar wing with an aspect ratio of 9·53 and a root chord of 22 ft. 7¼ in. The fuselage is an all-metal monocoque structure with a maximum diameter of 12 ft. The undercarriage is of retractable nosewheel type, the main members comprising four-wheel bogies retracting into the inner engine nacelles.

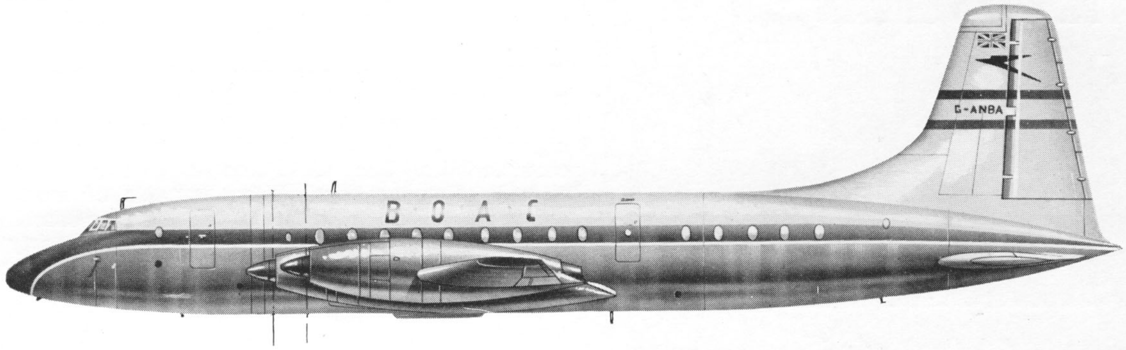
The first prototype Britannia flew on August 16, 1952, powered by four Bristol Proteus 625 (B.Pt.2) rated at 3,510 e.h.p. (3,200 s.h.p. plus 800 lb. residual thrust), and was followed on December 23, 1953, by a second prototype powered by the Proteus 705 (B.Pt.3) engines rated at 3,780 e.h.p. (3,320 s.h.p. plus 1,200 lb. thrust), which also powers the first fifteen production aircraft. This first production version is known as the Britannia 100, and the first of fifteen ordered by B.O.A.C. flew on September 5, 1954. The Britannia 100 has a basic interior layout permitting ready conversion from first-class accommodation for sixty-three passengers to a "tourist" version carrying ninety-two passengers. Maximum speed is 386 m.p.h. at 23,000 ft. Maximum cruising speed is 357 m.p.h. at 26,000 ft., and economic cruising speed is 340 m.p.h. at 28,000 ft., at which range with a 25,000 lb. payload is 4,100 miles or, with 15,000 lb. payload, 5,270 miles. Take-off distance to 50 ft. at sea level with no wind is 4,650 ft., and landing distance from 50 ft. is 3,265 ft. Empty weight is 78,598 lb. and maximum loaded weight is 150,000 lb. Overall dimensions are: span, 142 ft. 3½ in.; length, 114 ft.; height, 36 ft. 8 in.; wing area, 2,075 sq. ft.

The Britannia 100 will be succeeded in production by three later variants which possess an increase in fuselage length of 10 ft. 3 in. and are powered by the Proteus 755 (B.Pt.3) of 4,150 e.h.p. (3,650 s.h.p. plus 1,320 lb. residual thrust). Known as the Marks 200, 250 and 300—respectively freight, mixed freight and passenger, and passenger versions—the lengthened Britannias have normal gross weight increased from 140,000 to 155,000 lb., and payload from 25,000 to 43,000 lb. (Mk.200), 36,000 lb. (Mk.250), and 30,000 lb. (Mk.300).

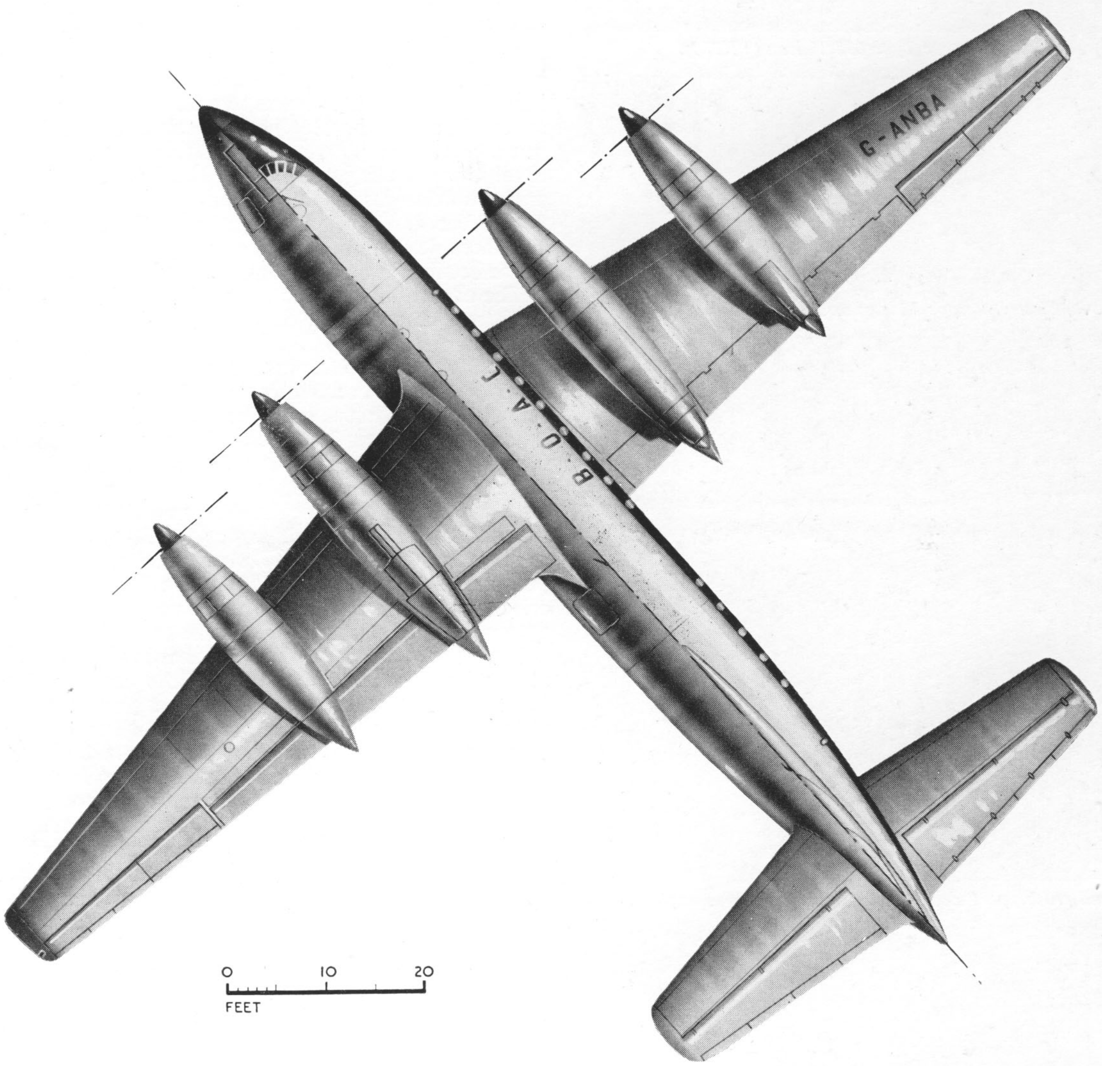
The Britannia 250 has been ordered by Australia's international airline Qantas, and will carry up to eighty-seven passengers and some eight tons of freight. The Britannia 300, ordered by B.O.A.C., will carry a maximum of 104 Tourist Class passengers and, like the Britannia 250, will be available in both medium-range and long-range versions, the former with the standard 6,800 Imp. gal. fuel capacity and the latter with additional wing tankage increasing total fuel capacity to 8,300 Imp. gal., providing an additional 610 miles range with full payload. This additional tankage will suffice to make the Britannia capable of operating non-stop London–New York services for at least 95% of the year while carrying a full load of 65–101 passengers. The maximun speed of the Mks.200 and 250 is estimated at 396 m.p.h. at 27,000 ft., and that of the Mk.300 at 400 m.p.h. at 22,000 ft.

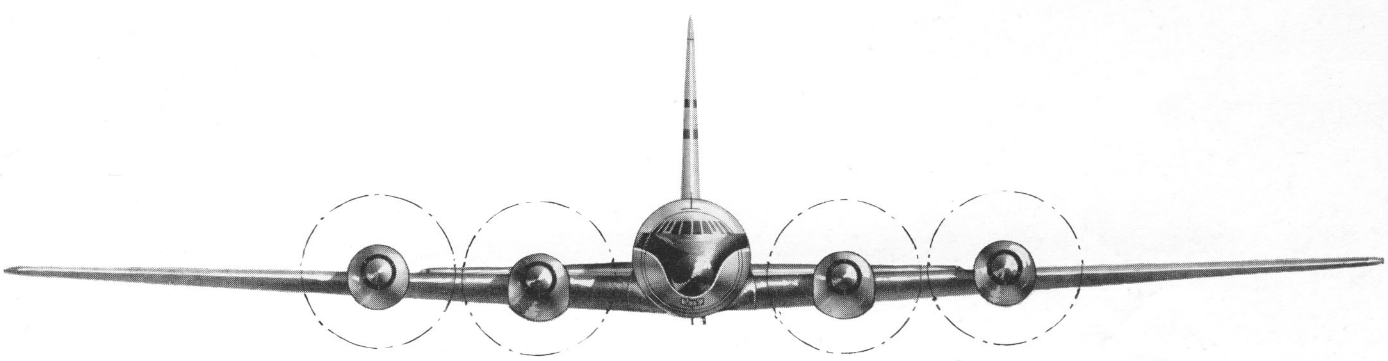
The medium-range Britannia 300 will have a range of 3,940 miles with capacity payload and 5,100 miles with 20,000 lb. payload and full tanks. Maximum cruising speed will be 389 m.p.h. A maritime reconnaissance variant of the Britannia with turboprops replaced by Wright Turbo-Cyclone piston-engines is to be built in Canada for the R.C.A.F. under the designation Canadair CL-28. An interim version will be known as the CL-27.

A further projected version of the Britannia, which has been referred to as the "Super Britannia", will be powered by four 4,000 e.h.p. Bristol B.E.25 constant-power turboprops. The power of the B.E.25 unit does not diminish with altitude and, in consequence, this later version of the Britannia will be able to operate from high-altitude airfields without any payload reduction. Cruising speed of the Super Britannia is likely to exceed 400 m.p.h. at 36,000 ft., and a thinner wing will be fitted.



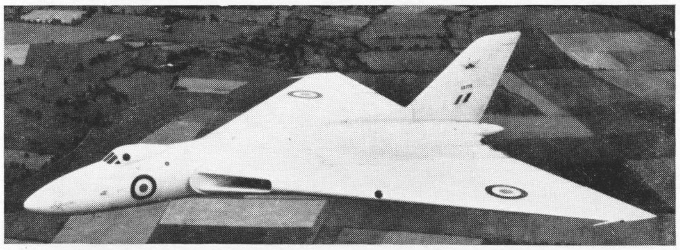
BRISTOL BRITANNIA 100

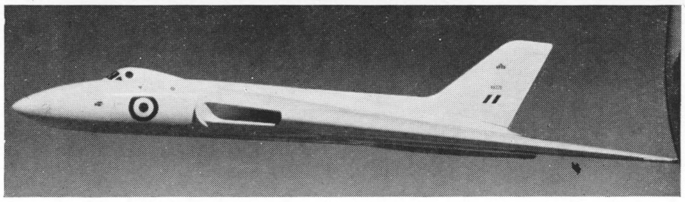




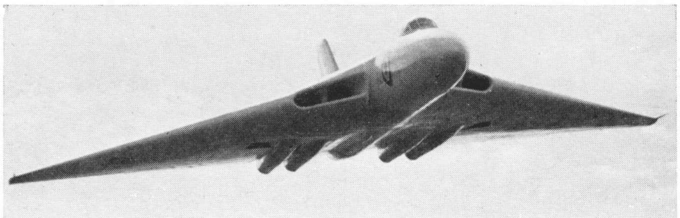
AVRO TYPE 698 VULCAN

(AUGUST) 1952

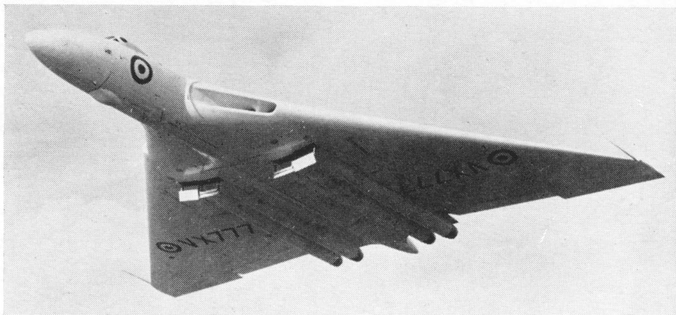


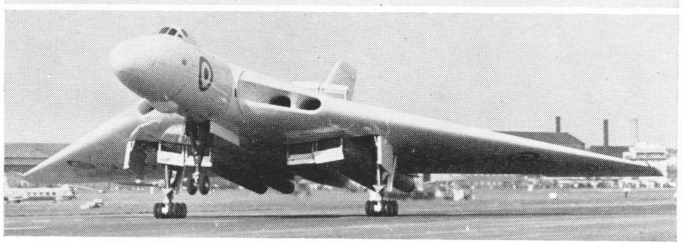


(Above) *The first prototype Type 698 Vulcan (VX770).*

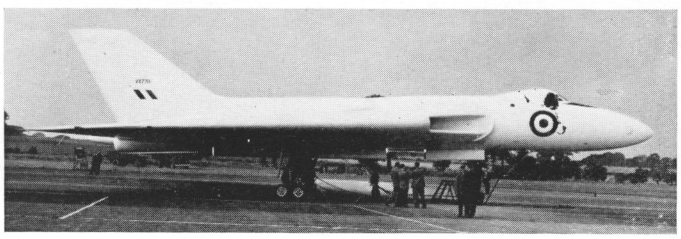


(Above) *First prototype Vulcan medium bomber.*

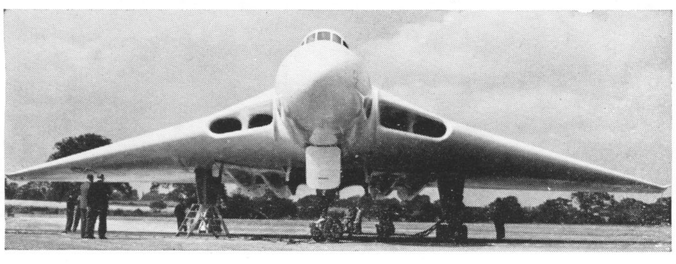




(Above) *Second prototype Vulcan (VX777) with Olympus engines.*



(Above and below) *First prototype Vulcan.*



The Type 698 Vulcan long-range medium bomber was developed to meet a specification issued on January 1, 1947, which called for an aircraft possessing exceptional load-carrying capabilities at high altitudes coupled with high subsonic speed and long-range characteristics. The A. V. Roe design team decided that an aircraft of conventional layout capable of meeting the requirements of the specification must have an inordinately high structural weight and, after making a wide variety of design studies of both orthodox and unorthodox configurations, a delta-wing planform was eventually chosen.

From the structural and operational viewpoint the delta offered large internal volume for stowage of fuel, undercarriage and engines, reducing external drag to the minimum, and its large surface area offered the low-wing loading necessary to meet the high-altitude performance requirements, simultaneously offering good take-off and landing characteristics without the use of flaps or other high-lift devices. Additionally, the stiff structure made possible by the low-aspect-ratio delta wing reduced the possibility of aeroelastic distortion effects.

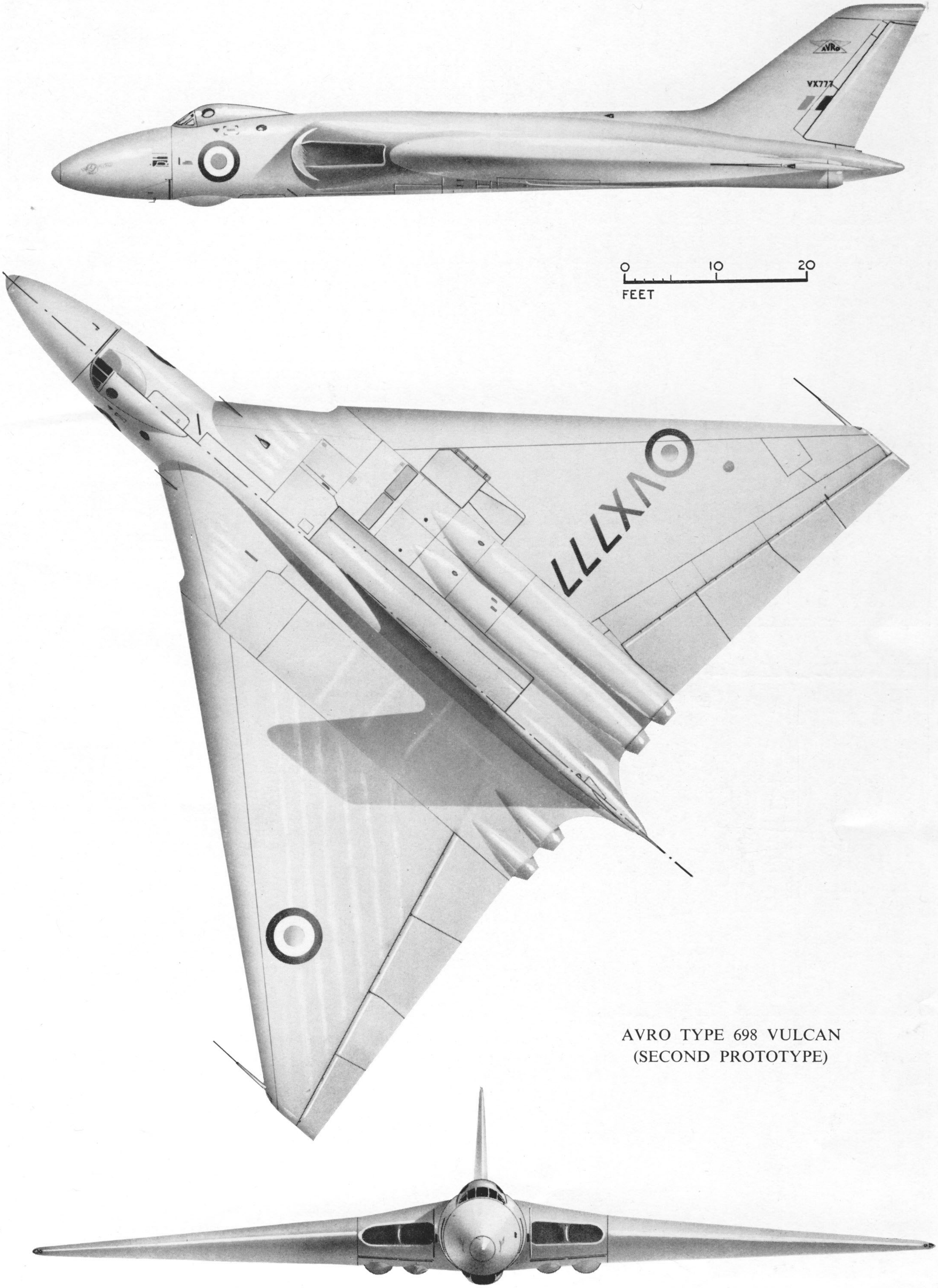
The project drawings for the Type 698 bomber were completed in the autumn of 1947, at which time no delta-wing aircraft had flown, and permission was granted for the construction of a series of one-third-scale flying models of the projected bomber to provide advance information on the flying characteristics of this revolutionary wing planform. The first of this series of flying scale-models (described on page 103), the Model 707, flew on September 4, 1949, and, together with its fellows, provided a considerable amount of data on the probable flight characteristics of the bomber at both high and low speeds.

The overall dimensions of the Type 698 were finalised in April 1950, and construction of the first prototype commenced. This aircraft, powered initially by four 6,500 lb. thrust Rolls-Royce Avon R.A.3 turbojets, was flown on August 30, 1952. The first prototype was subsequently re-engined with four 8,000 lb. thrust Armstrong Siddeley Sapphire A.S.Sa.6 turbojets, and a year later on September 3, 1953, the second or production prototype flew, powered by four Bristol Olympus B.Ol.1/2 engines each of some 9,500 lb. thrust and basically similar to the turbojets to be employed by the production Vulcan B.1. The latter may be of the recently announced Olympus B.Ol.6 type which is probably the most powerful British turbojet currently in production and possesses a thrust rating well into five figures. Production deliveries of the Vulcan B.1 will be made during 1955, and the type will enter service towards the end of 1956.

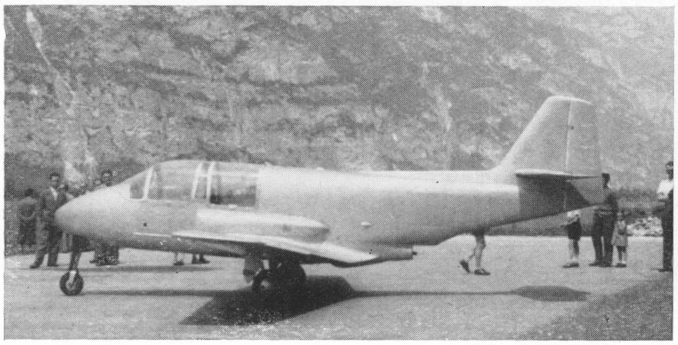
The wing geometry of the Vulcan is based on a 52° sweep angle at the leading edge; and despite the considerable root depth necessary to house the four Olympus engines, the thickness/chord ratio is only some 10 per cent. Overall span is 99 ft., and wing area is some 3,000 sq. ft. Assuming that, fully laden, the Vulcan weighs between 120,000 and 150,000 lb., with such a large gross area the wing loading is only between 40 lb. and 50 lb./sq. ft. The very large power-boosted control surfaces on the trailing edge comprise split-type outboard ailerons and inboard elevators, and air brakes comprising eight rectangular panels are disposed in pairs above and below the wing. These provide exceptional drag for their size, and each panel is mounted on two arms when extended to hold it clear of the wing surface where it would otherwise act as a lift spoiler.

The main undercarriage members are of eight-wheel bogie-type and retract into wells outboard of the engine bays. The twin-wheel nose gear retracts backwards into the fuselage. The circular-section fuselage has a diameter of some 9 ft., and overall length is 97 ft. 1 in. The crew members are all housed in the pressurised forward fuselage, and the bomb-bay has a length of some 28 ft.

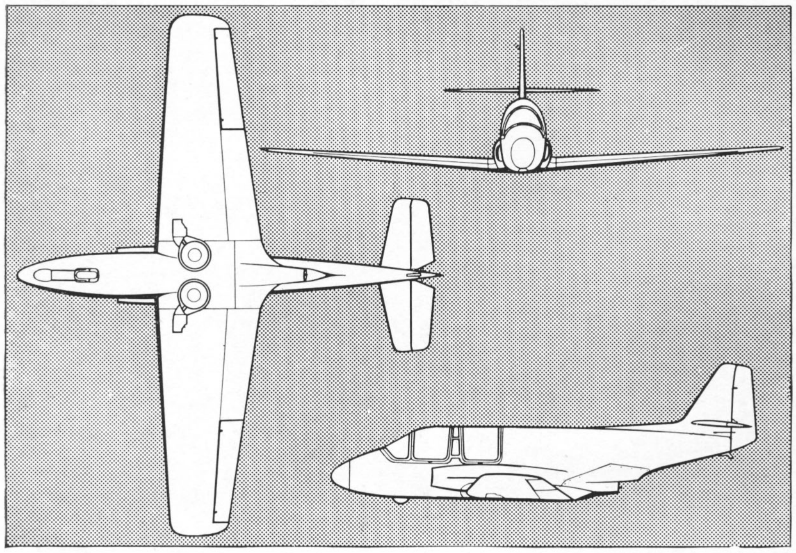
No details of the performance capabilities of the Vulcan may be revealed, but its clean lines reduce profile drag to a minimum and induced drag is low even at the highest operational altitudes due to the low superficial loading resulting from the considerable gross area of the delta wing. It can be assumed that this bomber will cruise at speeds in the vicinity of Mach 0·95 at altitudes up to 60,000 ft., and it may be usefully noted that a commercial transport based upon the design of the Vulcan, the Atlantic, is projected to cruise at nearly 600 m.p.h. at 40,000 ft. and to fly non-stop from London to New York in 5–6 hrs. The Atlantic design study features a greatly elongated fuselage able to accommodate from seventy-six first-class to 131 tourist-class passengers.



AVRO TYPE 698 VULCAN
(SECOND PROTOTYPE)



The Caproni Trento F.5 is the first light jet aircraft of Italian design.

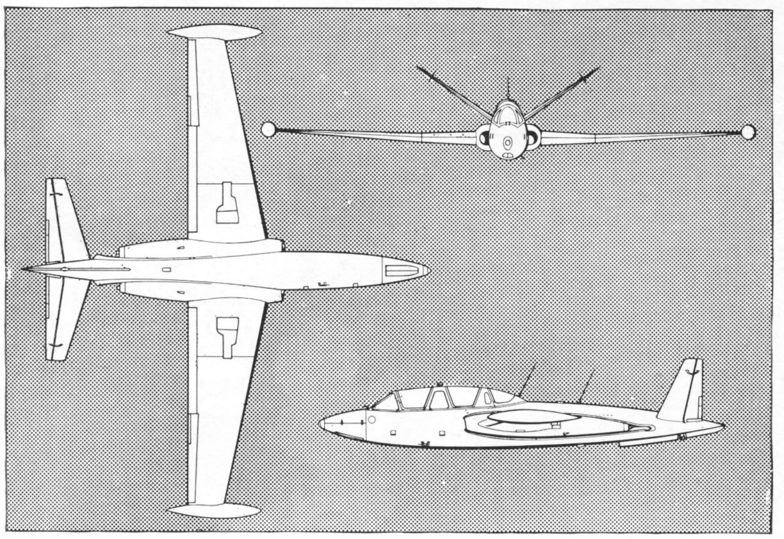


CAPRONI TRENTO F.5 (MAY) 1952

The Caproni Trento F.5 tandem two-seat light training and touring monoplane designed by Ing. Stelio Frati, is the first light jet aircraft of Italian design, and its construction is actually an adaptation of conventional glider technique. Flown for the first time on May 20, 1952, the Caproni Trento F.5 is powered by a 330 lb. thrust Turboméca Palas turbojet and is of all-wood construction.

Extreme simplicity is a notable feature of the design of the F.5. The wing has a single main spar with front and rear auxiliary spars and has stressed-skin plywood covering. Hydraulically-operated trailing-edge flaps are attached inboard of the ailerons, and the span and gross area are 25 ft. 9 in. and 107·63 sq. ft. respectively. Both seats are mounted ahead of the wing leading-edge. Dual controls are provided and both canopies can be jettisoned in an emergency. The Palas turbojet is aspirated by small lateral intakes level with the cockpit, and the engine is actually mounted below the main fuselage which is protected by a readily detachable fireproof "bath", ensuring that the jet stream clears the fuselage under all conditions. A fuel tank with a capacity of 38·8 Imp. gal. is contained in the fuselage aft of the second cockpit. Fuselage length is 21 ft. 7½ in. The nosewheel partly protrudes after retraction in order to furnish some protection for the engine in the event of a "wheels up" landing.

The F.5 weighs 1,032 lb. empty and 1,650 lb. loaded. Maximum speed is 224 m.p.h. at sea level and 242 m.p.h. at optimum altitude. Climb to 16,400 ft. is effected in 23 min., and service ceiling is 26,300 ft.



FOUGA C.M.170R MAGISTER (JULY) 1952

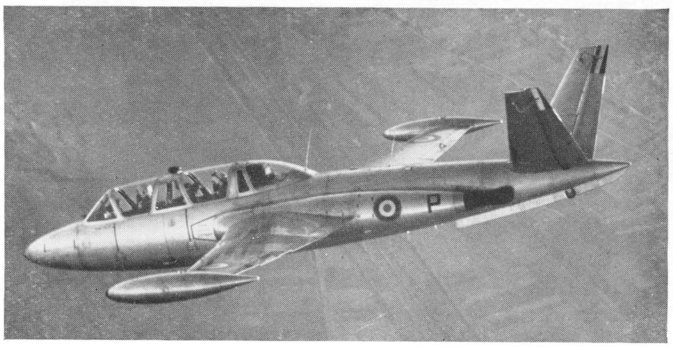
The Magister possesses the distinction of being the world's first jet basic trainer. Development commenced in 1948 when Fouga et Cie submitted a design for a tandem two-seat trainer to the *Ministère de l'Air*. Designated C.M.130R, this aircraft was to have been powered by two 350 lb. thrust Palas turbojets, but did not receive official support. Generally similar to the earlier design, the C.M.170R is heavier, and powered by two 880 lb. thrust Turboméca Marboré II turbojets. A contract for three prototypes was placed in December 1950.

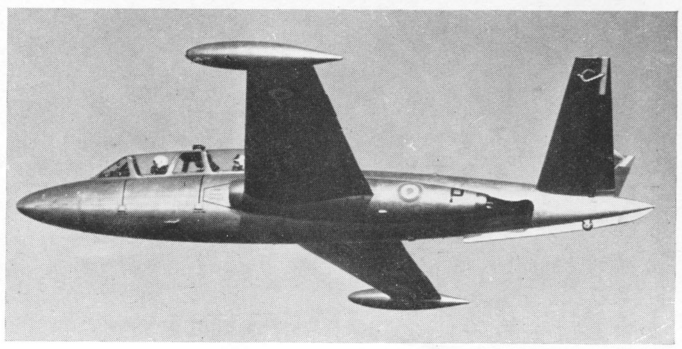
The first prototype C.M.170R flew on July 23, 1952, and was followed in February and July of the following year by the two further prototypes. One of these was initially flown with an orthodox tail for comparison with the "butterfly" type empennage standardised for the Magister. Orders were placed in 1953 for ten pre-production and ninety-five production Magister basic trainers for the *Armée de l'Air*.

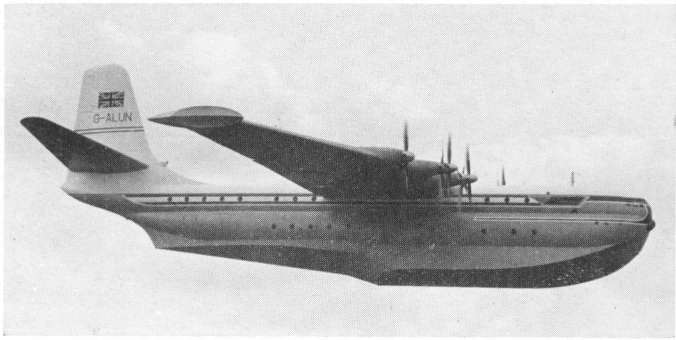
The Magister is of all-metal construction, with a retractable nosewheel undercarriage. The two Marboré turbojets are mounted close to the fuselage sides and, being close to the centre line, produce very little asymmetric thrust with one engine cut. Provision is made for an armament of two 7·5-mm. guns in the nose, and four rockets can be carried.

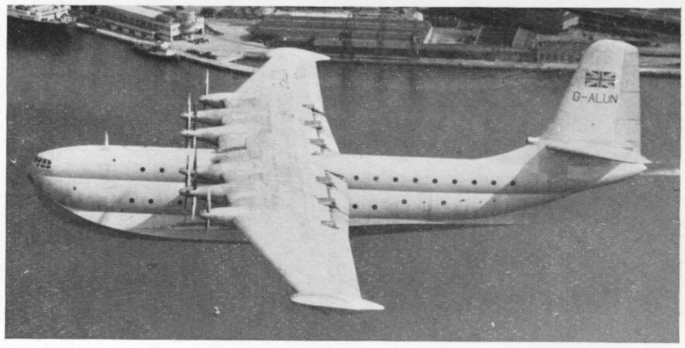
The Magister has a maximum speed of 423 m.p.h. at sea level and 444 m.p.h. at 30,000 ft. Range at 30,000 ft. is 570 miles, and initial climb rate is 3,350 ft./min. Empty and loaded weights are 3,968 lb. and 5,952 lb. respectively, and overall dimensions are: span, 37 ft. 1 in.; length, 32 ft. 2 in.; height, 9 ft. 2¼ in.; wing area, 186·1 sq. ft.

The Fouga C.M.170R Magister has the distinction of being the world's first jet basic trainer.



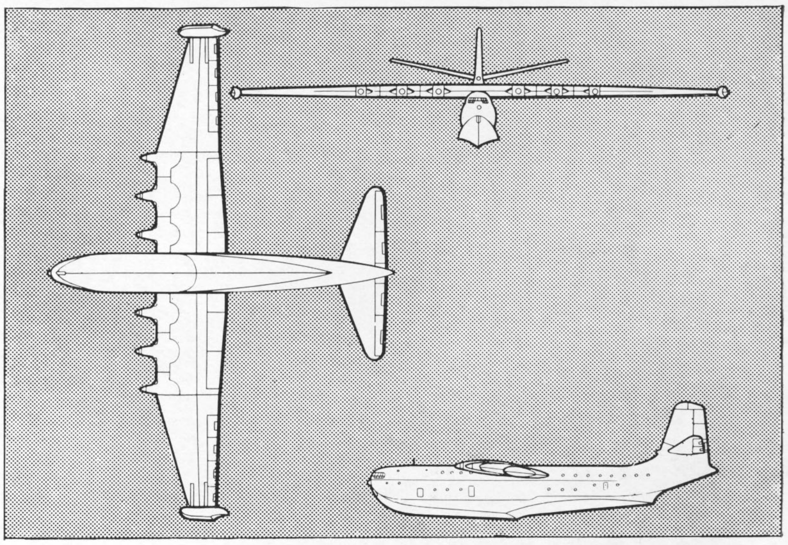






The largest turbine-powered aircraft flown to date, the first Princess (G–ALUN) is currently awaiting availability of more powerful engines.

SAUNDERS-ROE PRINCESS (AUGUST) 1952

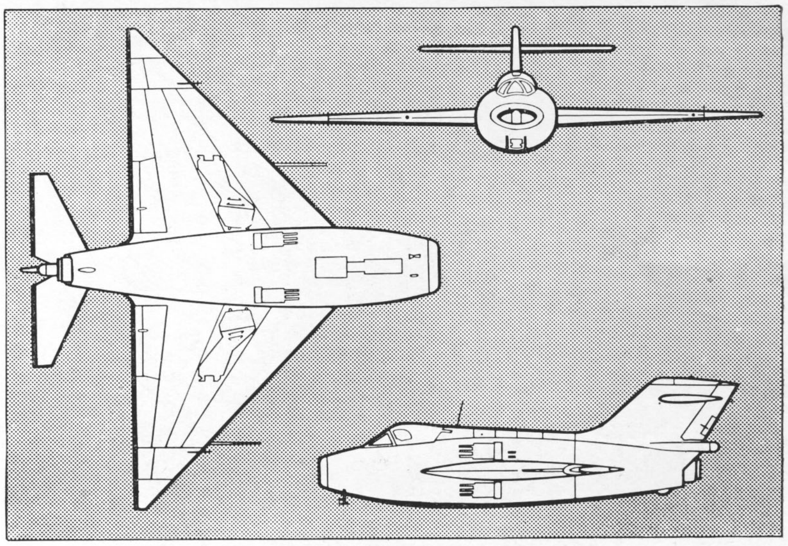


Undoubtedly one of the most impressive turbine-powered commercial aircraft yet produced, the S.R.45 Princess appeared at a time when the airline by whom it was originally to have been operated was committed to the use of land-based aircraft, and its future remains in doubt.

Designed to fly non-stop on stage-lengths of the order of 3,500 miles, the first of three Princess flying boats flew on August 22, 1952, powered by ten Bristol Proteus (600) B.Pt.2 Mk. 2 turboprops, in four coupled pairs and two single units, each providing 2,820 e.h.p. These units furnished insufficient power to provide the original designed performance, and plans to replace them with ten later Proteus units did not reach fruition, as the flying-boat's effective range would have been reduced to less than 2,000 miles. It is now considered likely that six more powerful turboprops (possibly Bristol B.E.25 constant-power type) will be installed in the first Princess and her two structurally-complete sister ships which have been stored pending a decision on the power plants.

The original estimated performance for the Princess included a cruising speed of 380 m.p.h. at 37,000 ft. or 360 m.p.h. at 32,500 ft., a range with a 50,000-lb. payload of 3,750 miles, and, with a 21,500-lb. payload, 5,270 miles. Estimated empty and loaded weights were 191,000 lb. and 330,000 lb. respectively, and overall dimensions were: span, 219 ft. 6 in.; length, 148 ft.; height, 55 ft. 9 in.; gross wing area, 5,250 sq. ft. The Princess had a total fuel capacity of 14,500 Imp. gal. and could accommodate more than a hundred passengers in its figure-eight section hull.

BOULTON PAUL P.120 (AUGUST) 1952

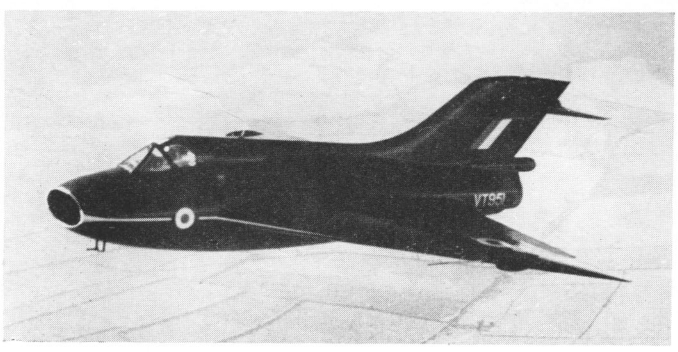


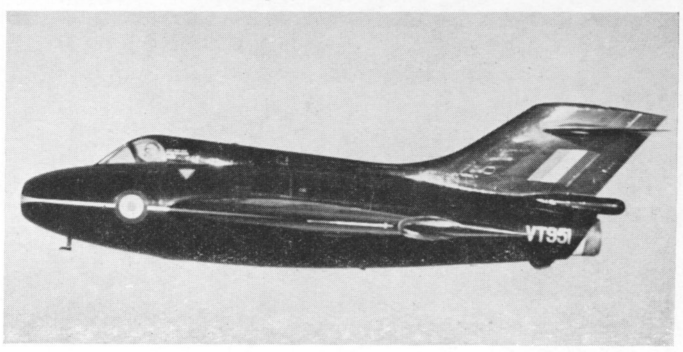
Built to further the delta-wing research programme initiated with the P.111, the Boulton Paul P.120 differed from its predecessor primarily in having an all-movable tailplane attached near to the tip of a redesigned fin and rudder assembly. The P.120 flew for the first time on August 6, 1952, but was destroyed in an accident caused by tail flutter on August 29, 1952, before a full comparison of its characteristics with those of the P.111 could be made.

Like the earlier delta research aircraft, the P.120 was powered by a Rolls-Royce Nene turbojet, the intake for which was of flat, ovoid form. Interesting air brakes in four segments around the fuselage a little way behind the cockpit were a feature of the P.120, and these were later incorporated on the earlier P.111. Whereas the P.111 had a housing for a braking parachute on the port side of the rear fuselage, that of the P.120 was mounted centrally under the rudder. The wing planform of the P.120 was identical with that of the P.111 with a span and area of 33 ft. 5½ in. and 200 sq. ft. respectively, and the leading edge was swept at an angle of 45°. The redesigned vertical tail surfaces with sweepback on the trailing edge increased overall length to 29 ft. 7½ in.

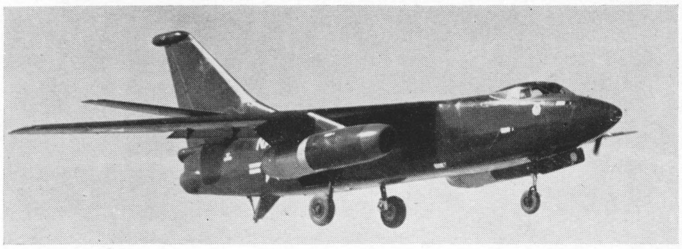
Notable features of the P.120 included the exceptionally wide-track undercarriage (14 ft. 5¼ in.), the main members of which folded inwards into wing housings (the nosewheel retracting rearwards), and the detachable wing-tips. Weighing some 10,000 lb. loaded, the P.120 was expected to attain very high subsonic speeds in level flight.

Derived from the P.111 tailless delta, the P.120 (VT951) was intended for comparative trials.

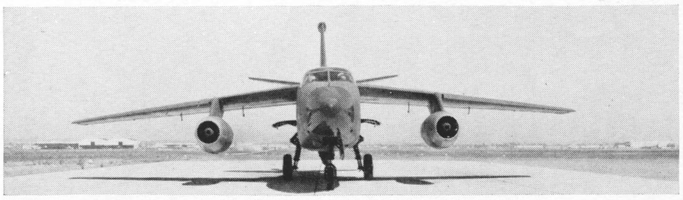


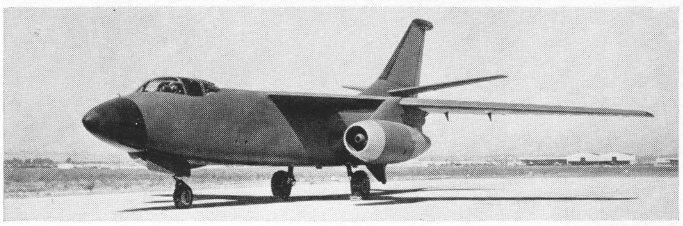


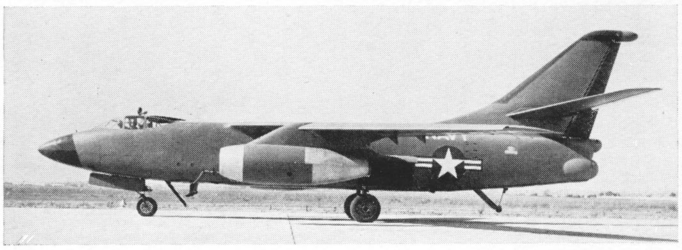
DOUGLAS A3D–1 SKYWARRIOR (OCTOBER) 1952



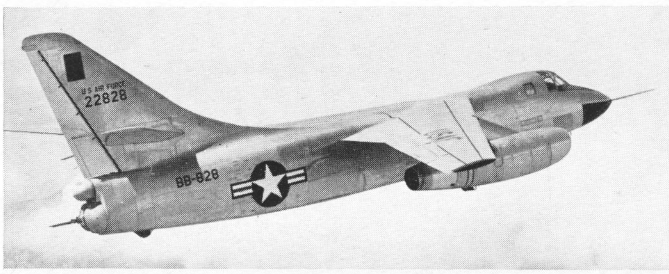
(Above) *The XA3D–1 Skywarrior (129412) with XJ40–WE–3 turbojets.*

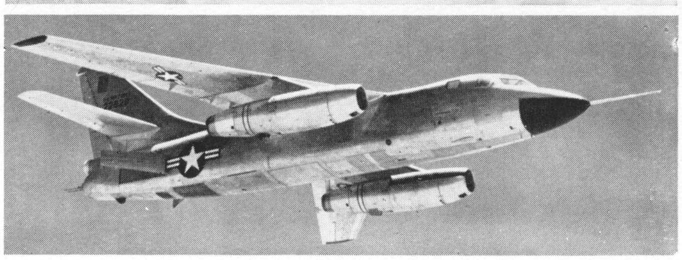




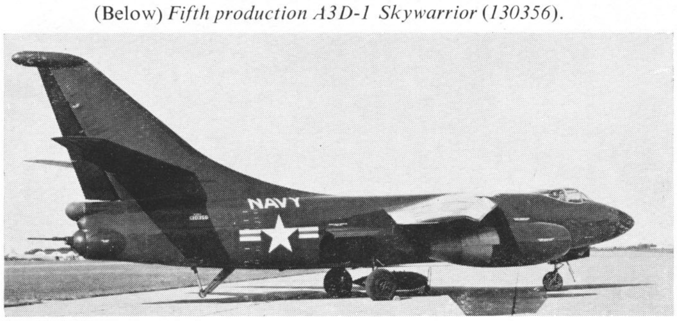


(Above) *First production A3D–1 (10352).* (Below) *First RB–66A (52–2828).*





(Below) *Fifth production A3D-1 Skywarrior (130356).*



This notable carrier-borne strike aircraft, designed to operate from the giant *Forrestal*-class carriers, is the largest deck-landing jet aircraft to be accepted for operational service. In production for the U.S. Navy and intended primarily to fulfil the strike role, the Skywarrior can also perform the roles of low-level mine-layer and torpedo-bomber, high-level precision bomber and, in its A3D–1P form with modified camera-nose, photographic reconnaissance.

It was originally proposed that the Skywarrior should be powered by the Westinghouse J40 turbojet, and the first of two XA3D–1 prototypes flew on October 28, 1952, powered by two 7,000 lb. thrust XJ40–WE–3 units, the 7,500 lb. thrust J40–WE–12 being proposed for the production A3D–1. However, serious development troubles led to the abandonment of further development of the Westinghouse turbojet, resulting in its replacement in the A3D–1 by two 9,700 lb. thrust Pratt and Whitney J57–P–12 units. These are mounted in underslung pods which project forward of the wing leading edge, and their thrust at take-off can be supplemented by twelve JATO bottles disposed on each side of the rear fuselage.

The shoulder-mounted wing is swept 36° at quarter-chord, and has an aspect ratio of 6·75. The thickness/chord ratio is 10% at the root and $8\frac{1}{4}$% at the tip. The wing carries leading-edge slots and large-area trailing-edge flaps. The outboard panels fold hydraulically for carrier stowage. The pressurised cabin accommodates a crew of three—pilot, pilot-bombardier and navigator—and a slide-type escape chute is provided in place of the more usual ejector seats. The elimination of ejector seats in favour of escape chutes resulted in a weight saving of 550 lb.

The internal-weapons bay has a length of some 15 ft. and can accommodate a variety of bombs, depth charges, mines or torpedoes. To avoid buffeting when the bomb doors open and the "hanging-up" in the bomb-bay of internally-stowed weapons due to the aerodynamic forces exerted at high speeds, a spoiler, or anti-buffet brake, in the form of a miniature air brake, is deflected immediately ahead of the front lip of the bomb-bay with the opening of the bomb doors. Sole defensive armament comprises a Westinghouse radar-directed tail turret containing two 20-mm. cannon. Installed as a complete unit, the turret provides automatic warning of approaching aircraft and automatically tracks the target, positions and fires the guns.

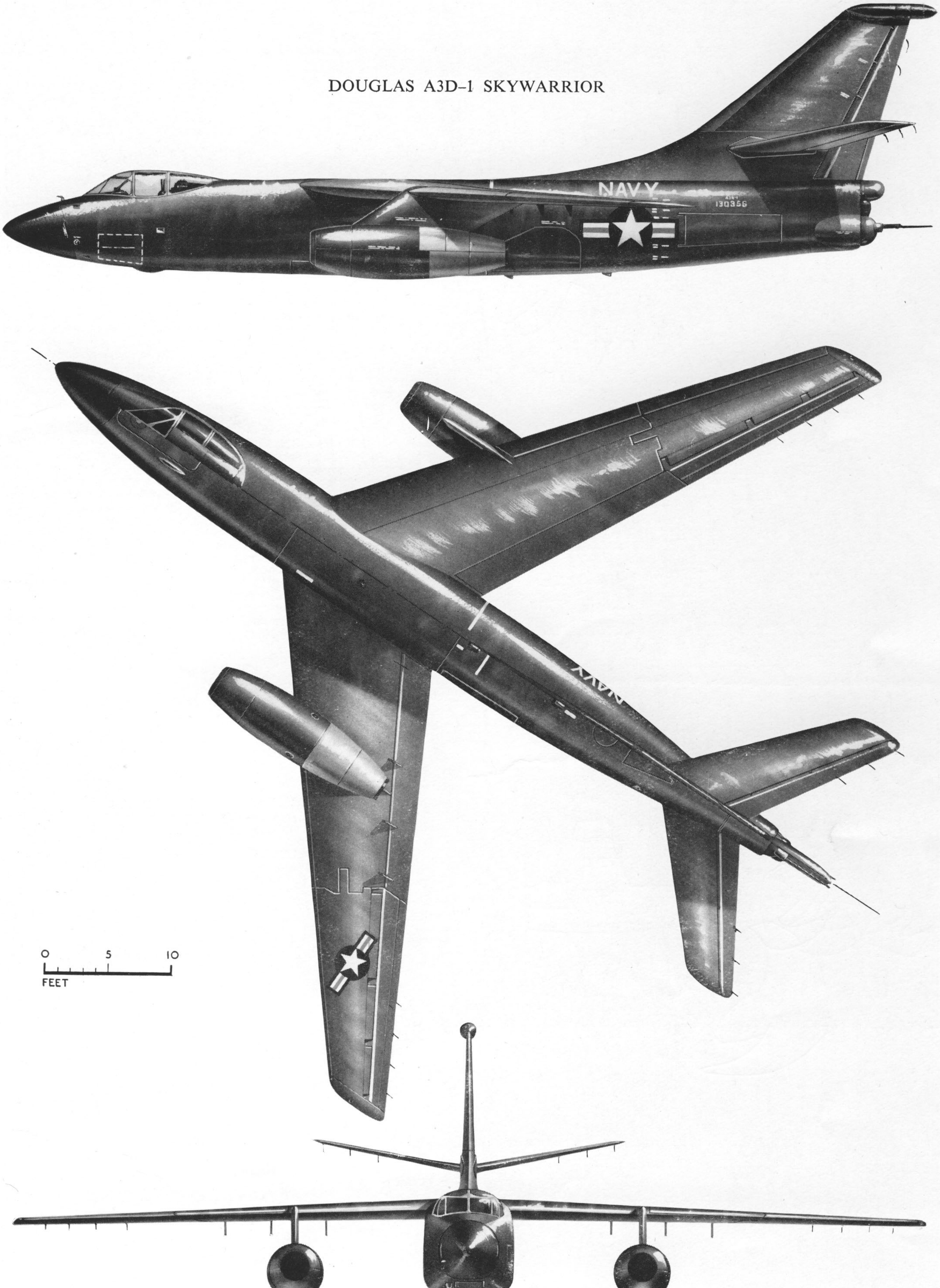
The large, moderately swept vertical tail surfaces carry an anti-spin parachute in a fairing at their tip and the 40° swept tailplane has marked dihedral. The vertical surfaces fold to one side to facilitate carrier stowage. The main members of the narrow-track undercarriage retract into the fuselage sides aft of the bomb-bay, the nosewheel retracts forward and a retractable tail-wheel prevents damage to the rear fuselage in high-angle landings. Hydraulically operated plank-type dive-brakes are attached to the rear fuselage. All fuel is carried in two self-sealing tanks in the fuselage fore and aft of the wing, and integral wing tanks stretching from the fuselage intersection to the wing fold line.

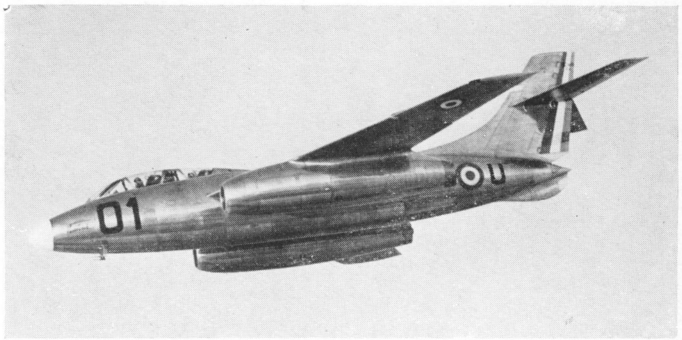
The Skywarrior has a normal loaded weight of 70,000 lb., but maximum loaded weight is likely to exceed 73,000 lb., at which weight wing loading will exceed 93·5 lb./sq. ft. Maximum speed and range are of the order of 640 m.p.h. and 1,700 miles respectively, and operational ceiling is 45,000 ft. A progressive development of the initial production model, the A3D–2, is now in production at Douglas's El Segundo division.

A land-based variant of the basic Skywarrior design is in production for the U.S.A.F. as the RB–66A reconnaissance-bomber and the B–66B night intruder. Flown for the first time on June 28, 1954, the RB–66A differs from its carrier-based counterpart in several respects. Power is provided by two 9,700 lb. thrust Allison J71–A–9 turbojets, the forward fuselage has been modified and the wing planform has been revised, with compound sweep on the trailing edge. Like the Skywarrior, the RB–66A carries a crew of three, and sole defensive armament is provided by a Westinghouse radar-directed twin-20-mm. gun barbette in the tail. Overall dimensions are generally similar: span 72 ft. 6 in., length 75 ft. $1\frac{1}{4}$ in., height 23 ft. 7 in., wing area 779 sq. ft.

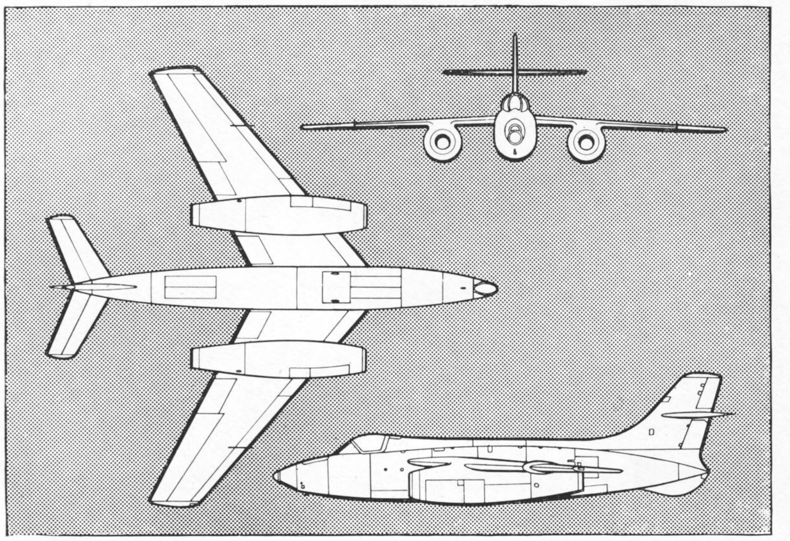
The B–66B night intruder will carry a forward firing armament of 0·5-in. or 20-mm. guns and 5-in. HVAR rockets underwing. In view of the elimination of wing- and tail-folding mechanism and deck-arrester gear, the performance of the land-based RB–66A and B–66B is likely to be higher than that of the carrier-borne Skywarrior.

DOUGLAS A3D-1 SKYWARRIOR





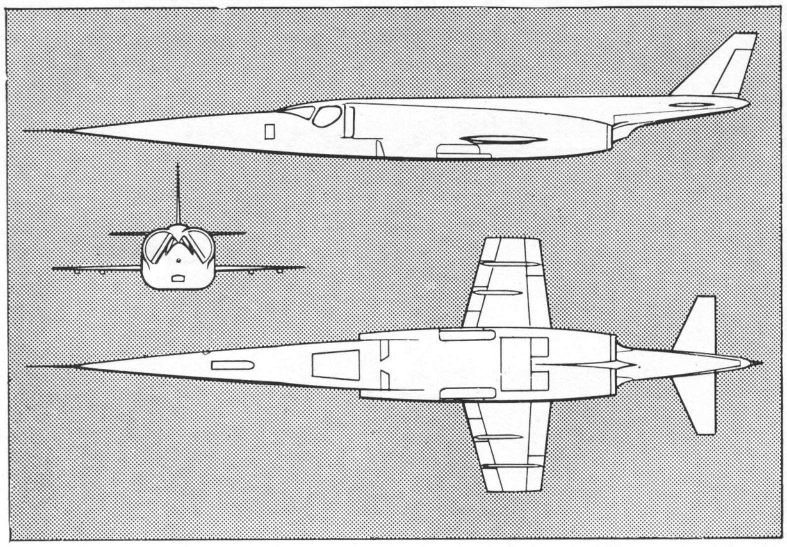
(Above, left) *The two-seat S.O.4050–001.* (Above, right) *The single-seat S.O.4050–003.* (Drawing) *The two-seat S.O.4050–003.*



SUD-OUEST VAUTOUR (OCTOBER) 1952

Design of the S.O.4050 Vautour was initiated in June, 1951, to meet a French Air Staff specification for an aircraft suitable for use in the all-weather fighter, close-support, light-bomber and reconnaissance roles, and three prototypes were built, the first of which, the two-seat S.O. 4050-001, flew on October 16, 1952, powered by two 5,280 lb. thrust SNECMA Atar 101B turbojets. This prototype was later re-engined with 6,170 lb. thrust Atar 101C units similar to those powering the second, single-seat prototype, and the two-seat third prototype was powered by two 8,000 lb. thrust Armstrong Siddeley Sapphire A.S.Sa.6 turbojets. Seventy Vautours powered by 7,275 lb. thrust Atar 101E-3 turbojets have been ordered.

The wing of the Vautour is swept at 35° at the leading edge. The all-metal fuselage is structurally interesting, being built up with frames and four main longerons but possessing no intermediate stringers. Another noteworthy feature is the undercarriage, which comprises tandem twin-wheel main units retracting fore and aft of the bomb-bay and small stabilising wheels retracting into the engine nacelles. Three major versions are projected: the A version is a single-seat close-support aircraft, the B version is a level bomber with a second crew member (bombardier) in the nose replacing the two 30-mm. cannon fixed armament, and the N version tandem two-seat all-weather fighter. The S.O.4050-002 has a top speed of 720 m.p.h. at sea level and an initial climb rate of 9,842 ft./min. Normal and maximum loaded weights are 30,865 lb. and 39,684 lb. respectively. Dimensions are: span, 49 ft. $6\frac{1}{2}$ in.; length, 51 ft. 1 in.; height, 14 ft. $1\frac{1}{4}$ in.; wing area, 484·376 sq. ft.



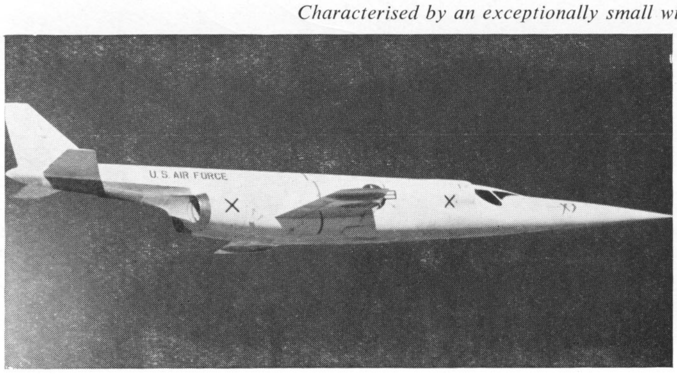
DOUGLAS X–3 (OCTOBER) 1952

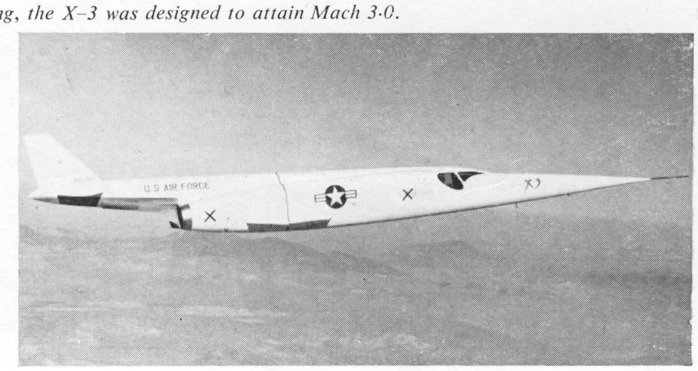
The Douglas X–3's design and construction posed problems of unprecedented complexity. Intended to explore the efficiency of turbojets and small-span, double-wedge aerofoils at speeds up to Mach 3·0 (1,960–2,280 m.p.h.), and to gather data on thermodynamic heating at speeds in the Mach 2·0–3·0 range, the X–3 has a tiny wing, spanning only 22 ft. 8 in. and possessing a thickness/chord ratio of some 5 per cent. It carries leading-edge flaps to improve camber, and split trailing-edge flaps.

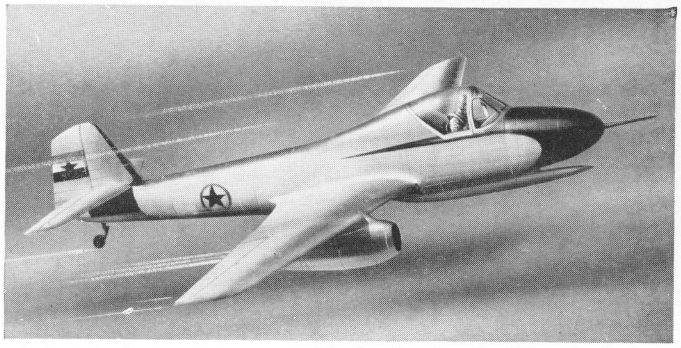
The size of the wing is markedly in contrast to the 66 ft. 9 in. fuselage, which, of triangular section, supports the diminutive tail assembly on a slender boom projecting above the jet-exhaust orifices. The triangular-shaped cockpit is designed to reduce the effects of thermodynamic heating and drag at supersonic speeds, and the X–3 carries 1,200 lb. of research instruments. There are 850 skin apertures to record pressures in flight; temperature readings are registered at 150 points, and 185 electric strain gauges indicate air loads.

The X–3 was designed to take two Westinghouse J46–WE–8 turbojets each developing 7,000 lb. thrust with afterburning, but increases in the overall diameter of this engine rendered it unsuitable for installation in the slim fuselage. It was therefore necessary to install two Westinghouse J34–WE–17 units, developing only 4,200 lb. thrust with afterburning, and with these the X–3 made its first flight on October 20, 1952. With the reduced power of the J–34s, it is unlikely that the designed speed of Mach 3·0 can be attained. Loaded weight of the X–3 is 27,000 lb. and wing loading is some 200 lb./sq. ft.

Characterised by an exceptionally small wing, the X–3 was designed to attain Mach 3·0.







The first jet aircraft of Yugoslav design, the type 451M was built for research purposes.

TYPE 451M (LATE) 1952

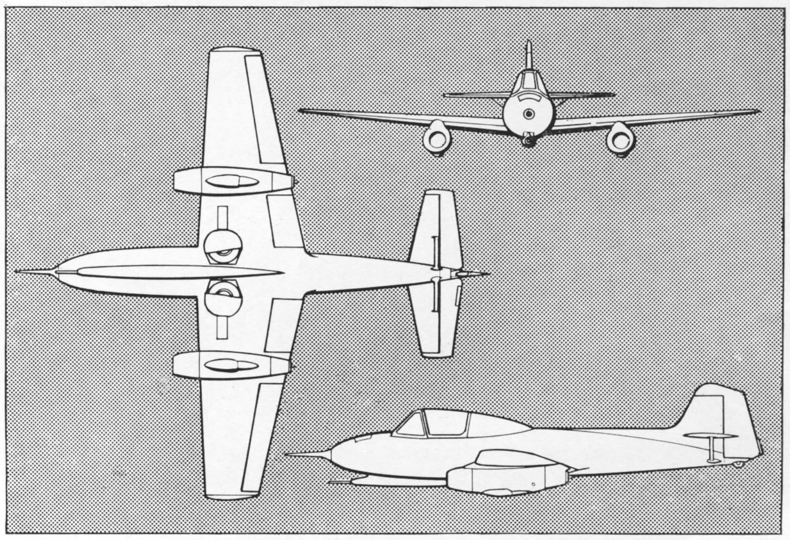
The first jet-propelled aircraft of Yugoslav design, the Type 451M was designed by Major Dragoljub Beslin and flown for the first time late in 1952. Powered by two 330 lb. thrust Turboméca Palas turbojets mounted under the low-positioned wing, the Type 451M was derived from the earlier Type 451 which, powered by two 160 h.p. Yugoslav-built Walter Minor 6-III piston-engines, featured a prone pilot position.

The first prototype 451M, built by the Ikarus factory at Zemun, near Belgrade, possessed an orthodox position for the pilot, but the second prototype reverts to a prone position similar to that previously tested on the Type 451.

Apart from general research purposes, the Type 451M was built as a potential lightweight ground attack and liaison monoplane and carried a 12·7-mm. gun in a long fairing under the fuselage nose.

The Type 451M was exceptionally small, its straight wing spanning only 21 ft. 11¾ in. The fuselage length was 18 ft. The main members of the tailwheel undercarriage retracted inwards into wing housings and the tailwheel was semi-exposed when retracted to act as a tail bumper in the event of a "wheels up" landing. Approximate loaded weight was 2,500 lb., and maximum speed was some 360 m.p.h.

No details are available concerning the second prototype, but it can be presumed that the reduced drag resulting from the use of a prone position for the pilot resulted in a slightly higher performance.

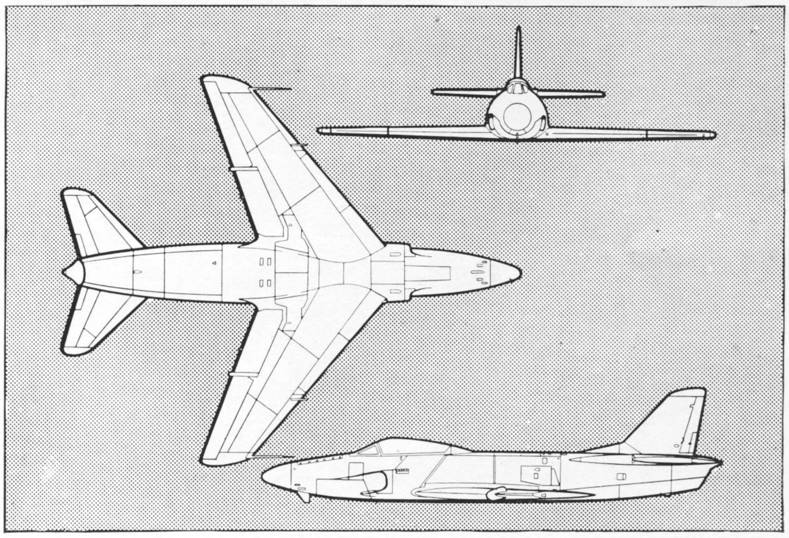


SAAB–32 LANSEN (NOVEMBER) 1952

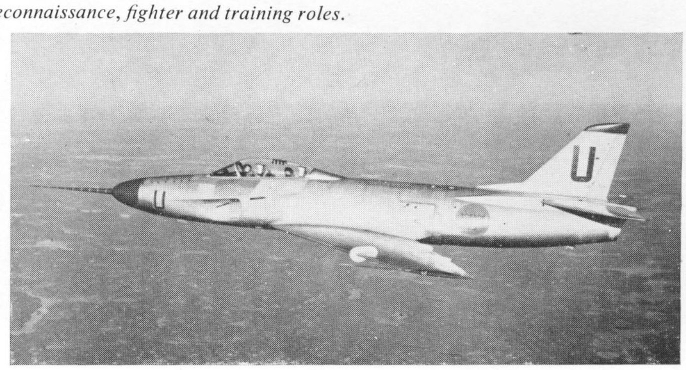
Designed to meet Swedish Air Board requirements for a two-seat attack aircraft which could also be used in the reconnaissance and all-weather fighter roles, the SAAB-32 Lansen flew for the first time on November 3, 1952, powered by a 7,500 lb. thrust Rolls-Royce Avon R.A.7 turbojet.

Design of the Lansen was initiated on December 20, 1948, and it was proposed to use the nationally-designed STAL Dovern II turbojet of 7,275 lb. thrust. Delays in the development of the Dovern resulted in the decision to use the Avon turbojet, which, in its afterburning R.A.7R version, is being built under licence in Sweden as the RM 5. The three prototypes are powered by British-built Avons, but the initial production model for the Swedish Air Force, the A 32 attack aircraft, will be powered by the RM 5 which, with afterburning, will provide 9,500 lb. thrust. A photo-reconnaissance version, the S 32, will reportedly have either the 9,500 lb. thrust Avon R.A.14 or the 10,000 lb. thrust Avon R.A.28, and the J 32 all-weather fighter variant will possibly use the latter turbojet.

The Lansen's wing is swept 39° at the leading edge, and carries leading-edge slots and large trailing-edge Fowler-type flaps. The fuselage cross-section is reminiscent of that of the Messerschmitt Me 262 fighter, and the crew of two are seated in tandem. An armament of four 20-mm. Swedish Hispano cannon is carried in the nose, and a variety of underwing loads can be carried, including sixteen 14·5-cm. Bofors rockets. Approximate loaded weight is 22,000 lb., and dimensions are: span, 42 ft. 8 in.; length, 49 ft. 2 in.; height, 16 ft. 5 in. The Lansen has a maximum speed of more than 700 m.p.h.

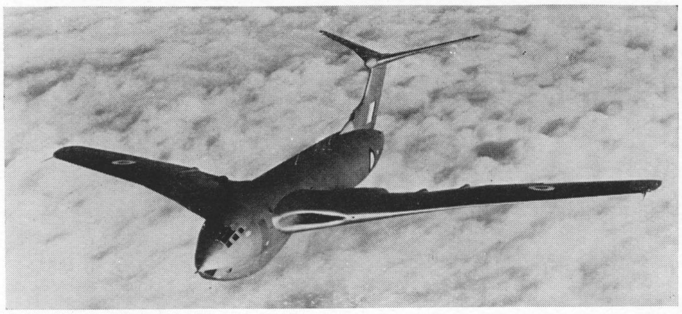


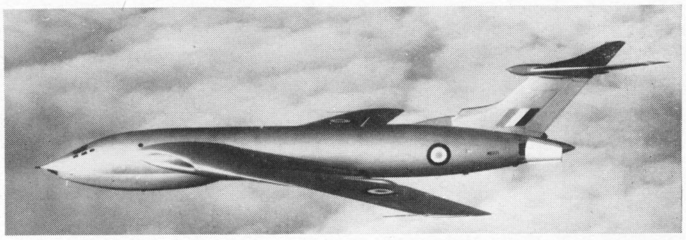
The Lansen is being developed for attack, reconnaissance, fighter and training roles.

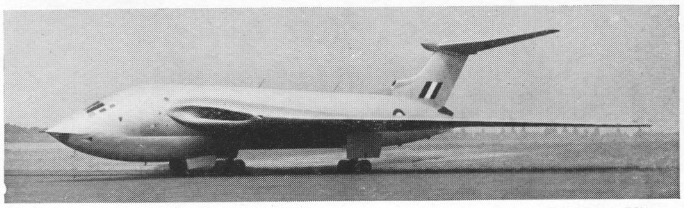


HANDLEY PAGE VICTOR

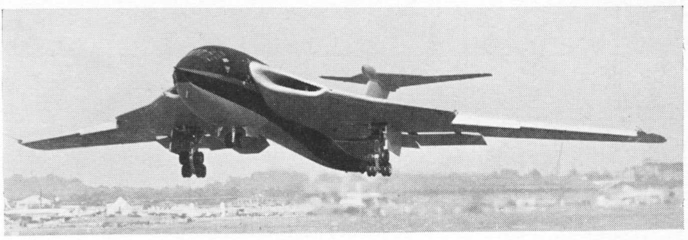
(DECEMBER) 1952

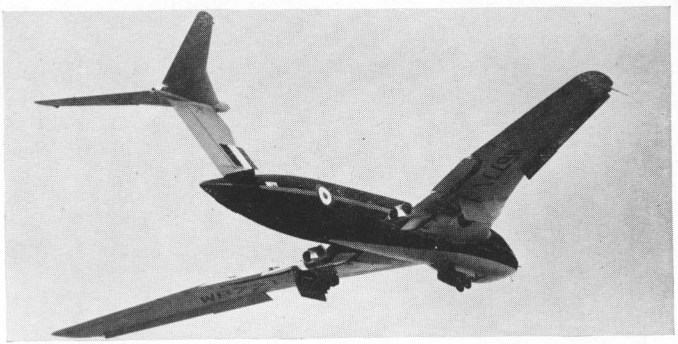


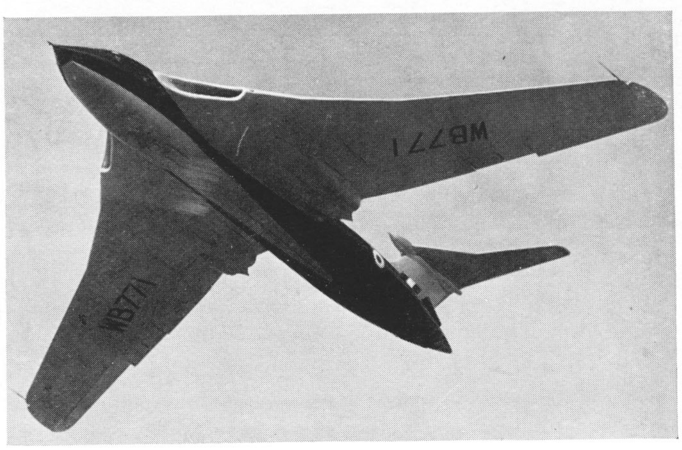




(Above and below) *The first prototype Handley Page H.P.80 Victor (WB771) powered by four Sapphire A.S.Sa.6. turbojets.*







Designed to meet the same general requirements as those for which the delta-winged Avro Vulcan was designed, the H.P.80 Victor represents a very different approach to the problems of producing a medium bomber with long-range characteristics, coupled with the ability to carry large loads at very high subsonic cruising speeds at altitudes of the order of 55,000–60,000 ft.

The most distinctive feature of the Victor is its wing planform, which is of so-called "crescent" form. The crescent-wing theory was formulated during the Second World War by the German Blohm und Voss and Arado companies, and the first aircraft to fly with a wing of this planform was the experimental H.P.88, intended to provide data on the flight characteristics of the wing for use in the development of the Victor bomber. The H.P.88 (described on page 130) was fitted with a modified quarter-scale model of the wing and was expected to furnish information on its flying qualities at speeds up to Mach 0·9, but the research aircraft was unfortunately destroyed before the wing's full characteristics could be determined.

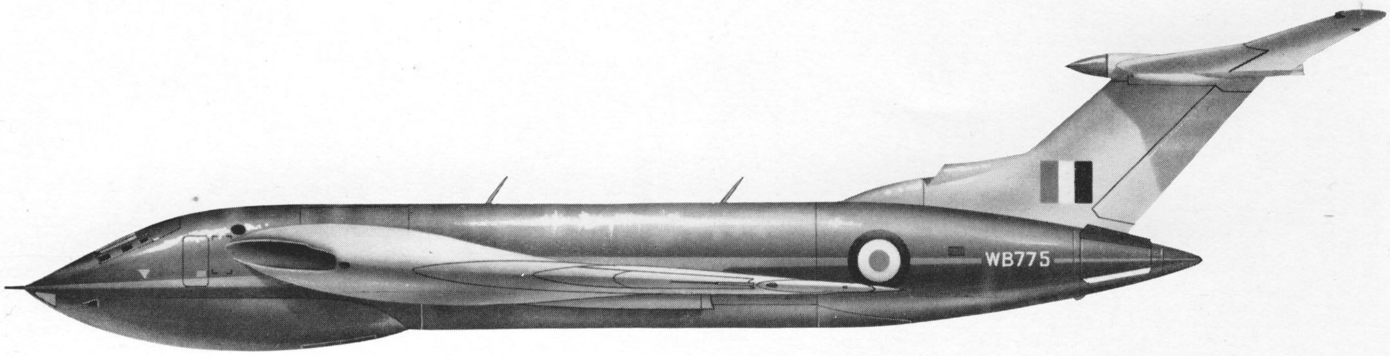
The crescent wing is essentially a compromise between the highly swept, low aspect ratio wing and the moderately swept, thin wing of relatively high aspect ratio. By progressive reduction of both sweep and thickness/chord ratio, the crescent wing has a constant critical Mach number from root to tip. Its sharply swept inboard sections provide sufficient depth to take engines and undercarriage main members, while the thin, moderately swept outer panels have reduced tendency to tip stall at low speeds. It is claimed for the crescent wing planform that, compared with other planforms evolved for high-altitude flight at near-sonic speed, it provides the best range-load performance for a given all-up weight, the greatest operating height for a given engine size, and the maximum loading flexibility because of its wide permissible range of c.g. movement.

The first of two Victor prototypes flew on December 24, 1952, and the second was flown on September 11, 1954. The prototype Victor is powered by four Armstrong Siddeley Sapphire turbojets, presumably of 8,000 lb. thrust A.S.Sa.6 variety, disposed in the wing roots, each pair being fed via a common intake, with effluxes on the trailing edge. Rearward-moving, trailing-edge flaps of large area are carried on the inboard wing sections and follow the contours of the jet nacelles. Two-section drooping flaps are fitted on the leading edges of the outermost panels only, increasing the camber for low-speed flight. Wing span is 110 ft.

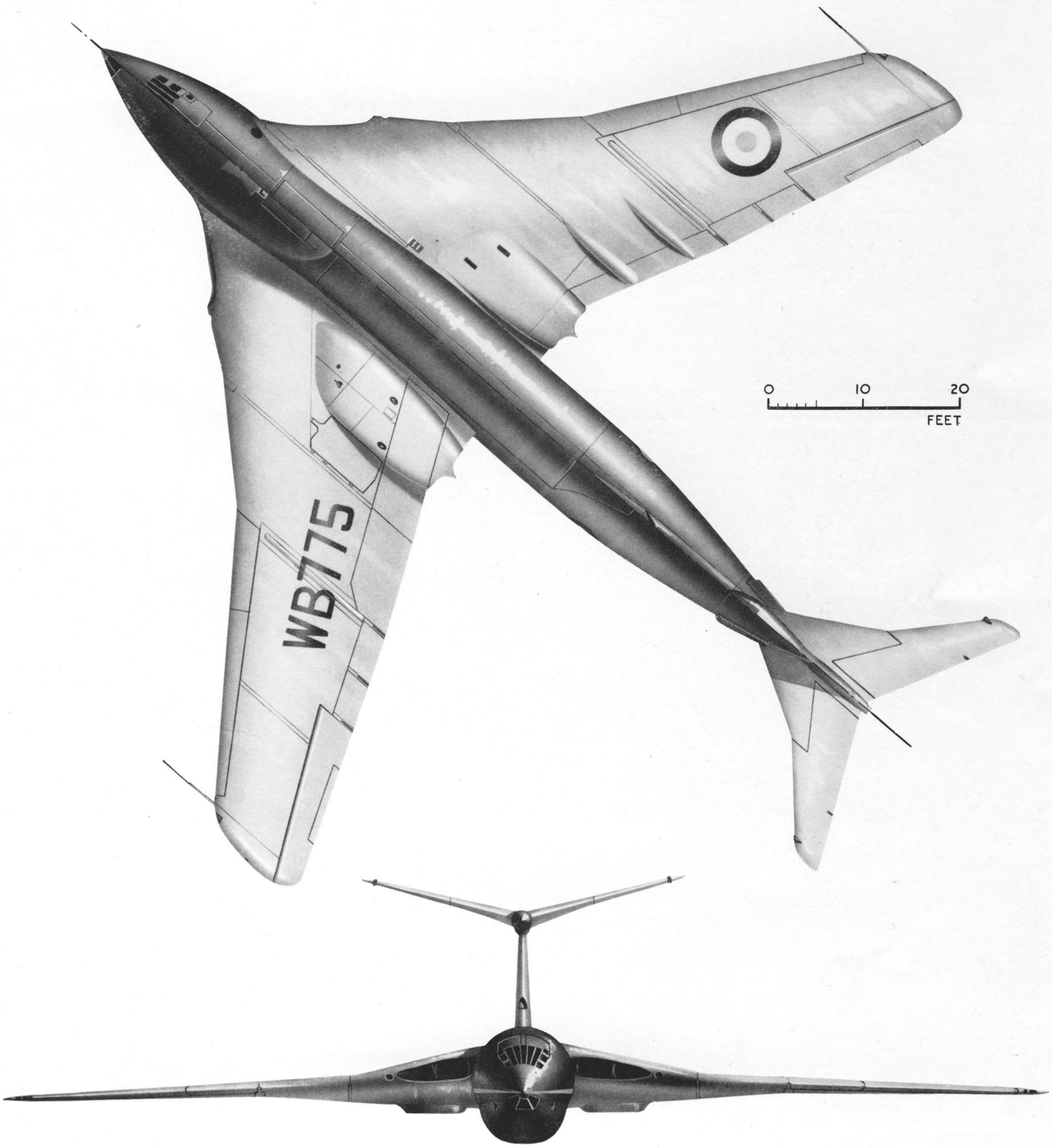
The fuselage of the Victor has a length of 114 ft. 11 in., the bulbous forward portion containing the pressurised crew compartment, the long-range bombing aids and the twin-nosewheel assembly. The main undercarriage members are of eight-wheel bogie-type to spread the weight of the aircraft over a large ground area and permit operation from airfields with runways of normal strength. These retract into the inboard wing sections. The geometry of the tail surfaces is unusual for an aircraft of the Victor's size. The tailplane has compound sweep on the leading edge and is mounted at the tip of the vertical tail surfaces. The prototype has a large dorsal fin containing an intake for combustion heaters, but these features will be deleted from the empennage of the production Victor B.1. Overall height is 26 ft. 9 in. Large hinged air-brakes are mounted on the tail cone.

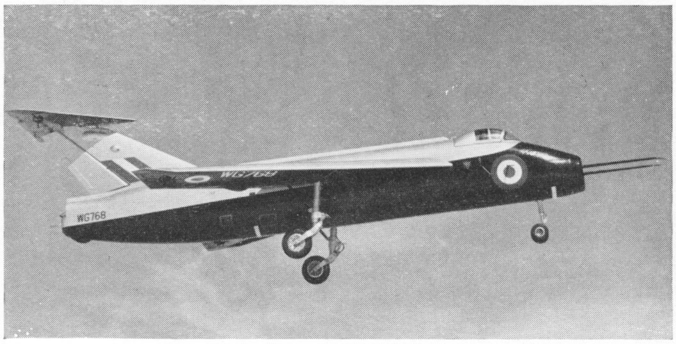
While no performance details concerning the Victor are available for publication, it is reasonable to suppose that production Victor bombers will have later Sapphire turbojets with five-figure thrust ratings, such as the 10,200 lb. thrust A.S.Sa.7, and will be capable of attaining speeds close to Mach 1·0 (660 m.p.h.) at altitudes up to 60,000 ft. at which the bomber will be virtually immune from attack by existing fighters. Normal range is likely to exceed 3,000 miles by a handsome margin, and loaded weight will be of the order of 150,000–175,000 lb. Initial production deliveries of the Victor B.1 will be made during the course of 1955, and the type is likely to enter service with R.A.F. Bomber Command towards the end of 1956.

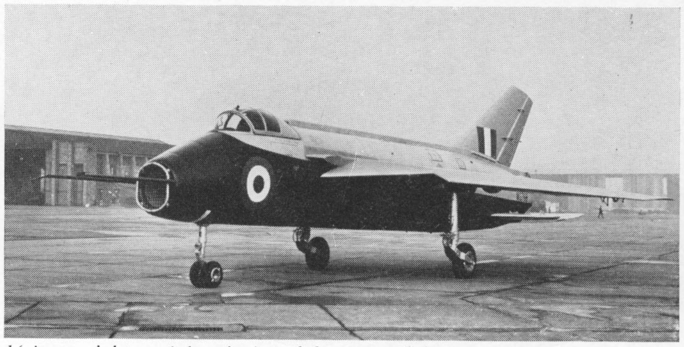
An intercontinental air liner, the H.P.97, is projected by the Handley Page company, employing the wing and tail assemblies of the Victor bomber. With a load-carrying capacity of 50,000 lb. and providing accommodation for a maximum of 150 passengers, the H.P.97 has an estimated cruising speed of 580 m.p.h. at 50,000 ft., and is capable of flying, non-stop, the 3,455 miles between London and New York.



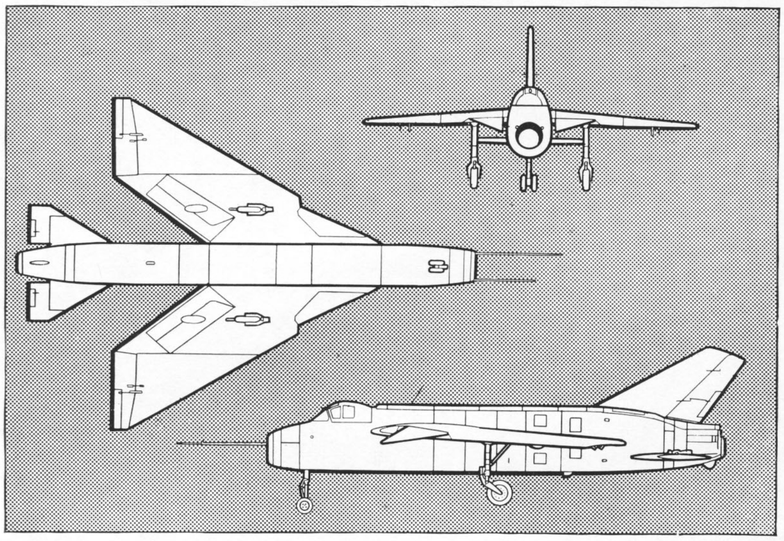
HANDLEY PAGE H.P. 80 VICTOR (SECOND PROTOTYPE)







(Above, left) *The S.B.5 with wing at 60° sweep angle and* (above, right, and drawing) *with low-set tailplane.*

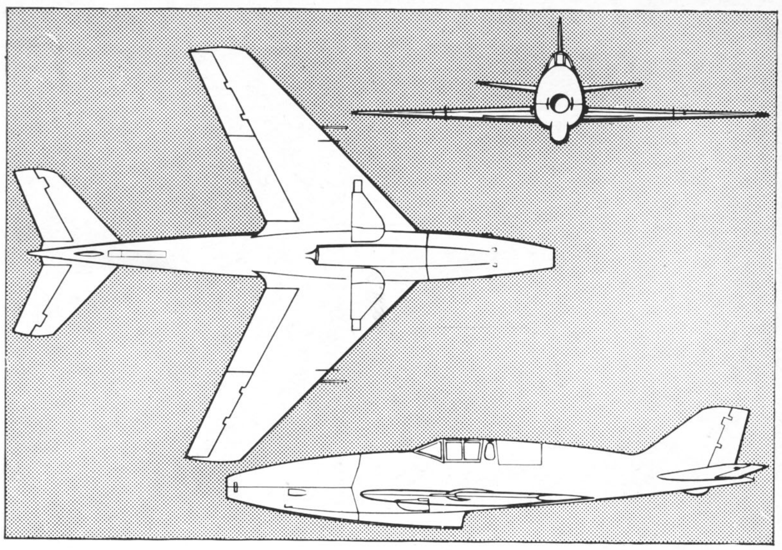


SHORT S.B.5 (DECEMBER) 1952

The Short S.B.5 is essentially a flying scale-model of the English Electric P.1 single-seat fighter, built at the request of the Ministry of Supply, after the basic design of the P.1 had been finalised, in order to provide advance data on the low-speed characteristics of the fighter. Air flow tends to break away at the tips of highly swept wings and results in some loss of lateral control, and the S.B.5 was designed so that flight trials could be conducted with the wing at sweep angles of 50°, 60° and 69°, and the tailplane in high and low positions.

Powered by a 3,500 lb. thrust Rolls-Royce Derwent turbojet, the S.B.5 flew for the first time on December 2, 1952, initial trials being conducted with the wing swept at an angle of 50° (at which angle wing span was 35 ft. 2¼ in.) and with the delta tailplane mounted at the extreme tip of the fin. The tailplane angle of incidence could be changed in flight over a range of 10° negative to 10° positive. A further series of tests were conducted with the wing at a 60°-sweep angle (30 ft. 6 in. span), and in January 1954, the third test phase commenced with the tailplane attached below the rear fuselage. For these tests drooping inboard wing sections were fitted to delay the stall and improve longitudinal stability, wind-tunnel tests having proved this arrangement to be more efficacious when used in conjunction with the low-set tailplane than the full-span drooping edge employed for previous tests.

For the final test phase, the wing will be swept 69° (25 ft. 11¾ in. span), becoming virtually delta in planform. The tailplane will revert to its former high position. Overall length of the S.B.5 is 47 ft. 4 in. and height (high tailplane) is 16 ft. 7 in.



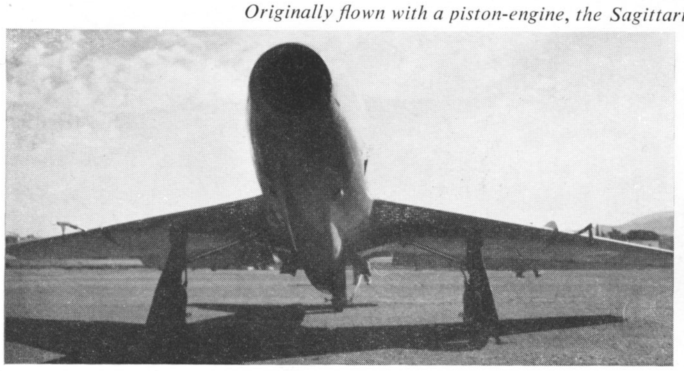
AMBROSINI SAGITTARIO (JANUARY) 1953

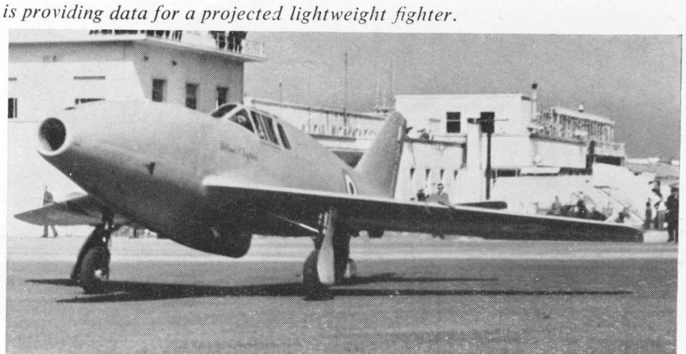
The Sagittario (Archer) was originally built to provide data for a projected transonic fighter known as the Vindex. Employing the basic fuselage of the Ambrosini Super S.7 trainer married to a new, 45° swept-wing and swept-tail surfaces, the Sagittario flew for the first time on January 5, 1953, powered by a Turboméca Marboré II turbojet of 836 lb. thrust mounted in the nose and exhausting under the fuselage. Initial flight trials with the airframe had previously been conducted with an Alfa Romeo 115ter piston engine, in which form the machine was known as the Freccia (Arrow).

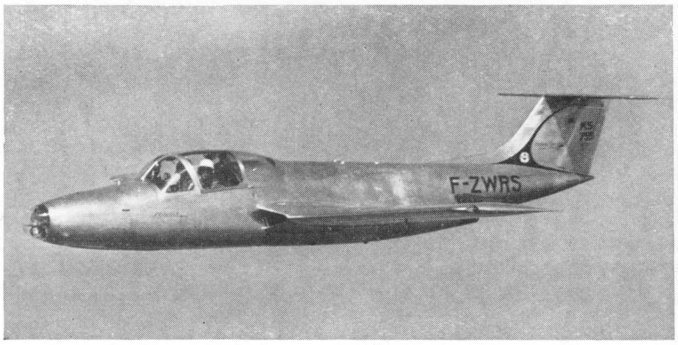
The basic design of the Sagittario is claimed to be capable of attaining Mach 1·05, but the initial wooden prototype has structural limitations considerably below this figure, and a two-seat all-metal version is currently under construction and is intended to further the research programme initiated with the first Sagittario. Although originally intended purely for research purposes, the basic design is now considered suitable for adaptation as a light fighter, and a further single-seat version, the Sagittario II, is projected. The Sagittario II will be powered by a 4,000 lb. thrust Rolls-Royce Derwent R.D.9 turbojet installed in a slightly deeper fuselage. Of all-metal construction, it will feature several design refinements, including a nosewheel undercarriage, a " bubble " cockpit canopy, a Martin-Baker ejector seat, and two 30-mm. cannon.

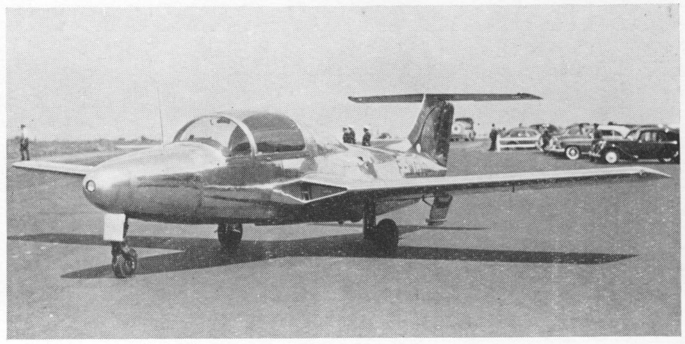
The first Sagittario has a maximum speed of 348 m.p.h. at 13,123 ft., a range of 354 miles, and a service ceiling of 26,246 ft. Loaded weight is 5,070 lb. Dimensions are: span, 24 ft. 7 in.; length, 30 ft. 7 in.; height, 4 ft. 11 in.; wing area, 157·153 sq. ft.

Originally flown with a piston-engine, the Sagittario is providing data for a projected lightweight fighter.



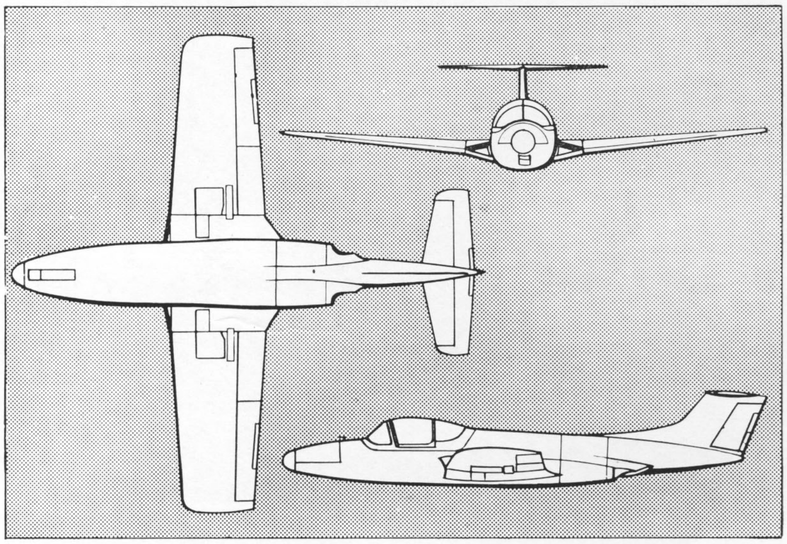






(Above, left and drawing) *The M.S.755 Fleuret.* (Above, right) *The M.S.760 Paris.*

MORANE-SAULNIER M.S.755 FLEURET (JANUARY) 1953

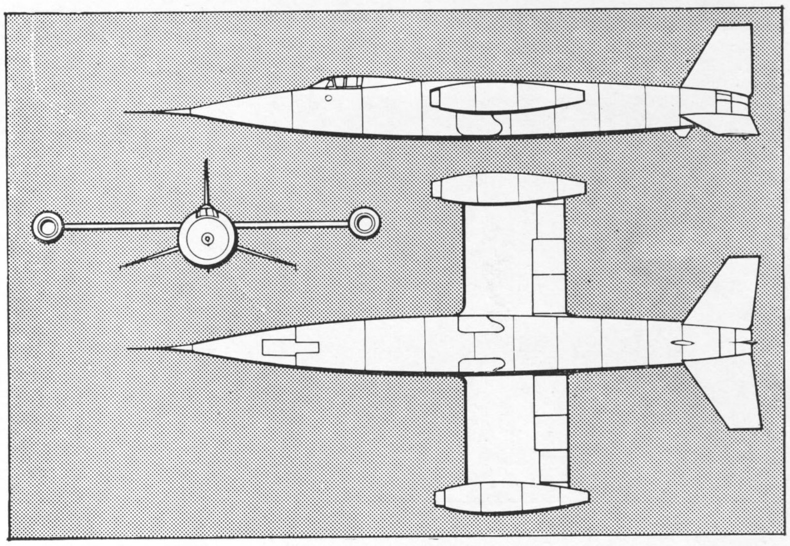


In a similar category to the Fouga C.M.170R Magister, the M.S.755 Fleuret light jet trainer flew for the first time on January 29, 1953. Certain parallels can be drawn between the Fleuret and the Magister; both are powered by two 880 lb. thrust Turboméca Marboré II turbojets located side by side in the fuselage, an arrangement chosen to simulate the flying qualities of a single-jet fighter as closely as possible while providing twin-engine safety, and weights and performances are similar. However, whereas the Magister offers tandem seating for pupil and instructor, the Fleuret has side-by-side seating, preference for the former arrangement influencing the French Air Force in its choice of the Magister for production.

Of all-metal construction, the Fleuret carries two 7.5-mm. guns and very comprehensive instrumentation, and in order to save the weight of ejector seats, in an emergency a hatch in the floor is jettisoned, an aerodynamically-balanced trap is lowered and the seats tip backward to precipitate their occupants through the bottom of the fuselage. The Fleuret has a speed range from sea level to 30,000 ft. of 428 m.p.h. to 484 m.p.h.; initial climb rate is 3,740 ft./min. Range 435 mls.

A four-seat development of the Fleuret, the M.S. 760 Paris, flew for the first time on July 29, 1954, and is intended as a fast liaison aircraft. The Paris has slightly larger span and length than the Fleuret, span being 33 ft. 3½ in. as compared to 31 ft. 8 in., and length is 32 ft. 10¾ in. as against 32 ft. 2 in. The Paris has a maximum cruising speed of 419 m.p.h. at sea level, and weights are (Fleuret quoted in parentheses): empty, 4,246 (4,222) lb., loaded, 7,275 (5,875) lb.

SUD-OUEST TRIDENT (MARCH) 1953

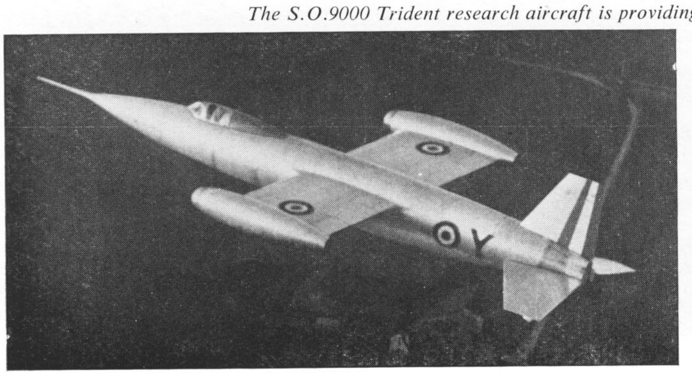


The S.O.9000 Trident was originally designed as a supersonic target-defence interceptor fighter but was completed as a research aircraft, the first prototype flying on March 2, 1953. A second prototype crashed on its initial flight in September 1953. The Trident is, in effect, a three-engined aircraft, an 880 lb. thrust Turboméca Marboré II turbojet being centrally mounted on each tip of the thin, low-aspect ratio wing for cruising flight and landing, and a triple-barrel rocket motor in the rear fuselage. The rocket motor comprises three SEPR 251 units each providing 2,755 lb. thrust at full power.

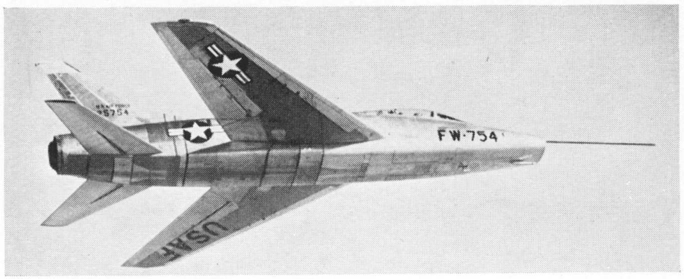
The fuselage of the Trident primarily serves the purpose of a fuel tank and contains sufficient rocket fuel to enable the SEPR battery to run at full thrust for 4·5 min. Initial flight trials were made prior to the installation of the rocket battery, and the Trident flew on rocket power alone for the first time on September 4, 1954. The tail surfaces of the Trident are unusual, comprising single all-moving tailplanes with marked anhedral and a single vertical surface. The Trident has a design limiting Mach number of 1·6 and a ceiling of 59,000 ft. At its loaded weight of 11,000 lb. the Marboré turbojets develop insufficient power to enable the Trident to take off fully-loaded without recourse to its rocket battery. Overall dimensions are: span, 26 ft. 9 in.; length, 45 ft. 11 in.; height, 12 ft. 1½ in. Wing area is only 99·027 sq. ft.

The S.O.9000 Trident has furnished data for the S.O.9050 supersonic interceptor which will employ a basically similar power-plant arrangement and will carry an air-to-air missile armament.

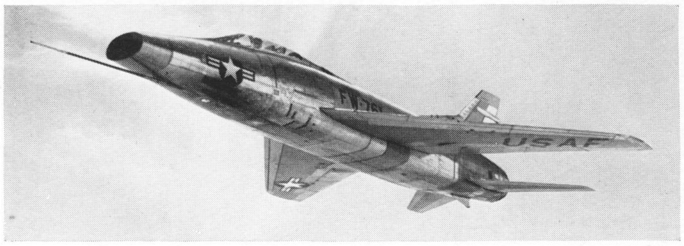
The S.O.9000 Trident research aircraft is providing data for the S.O.9050 target-defence interceptor.



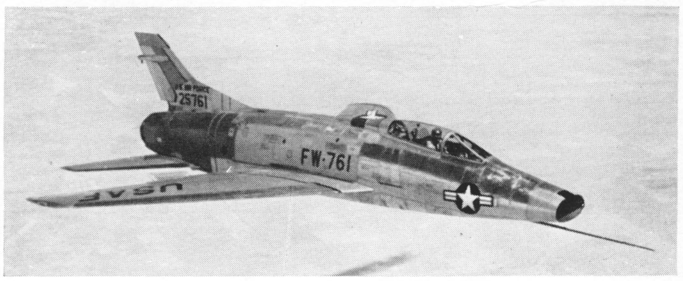
NORTH AMERICAN F–100A SUPER SABRE



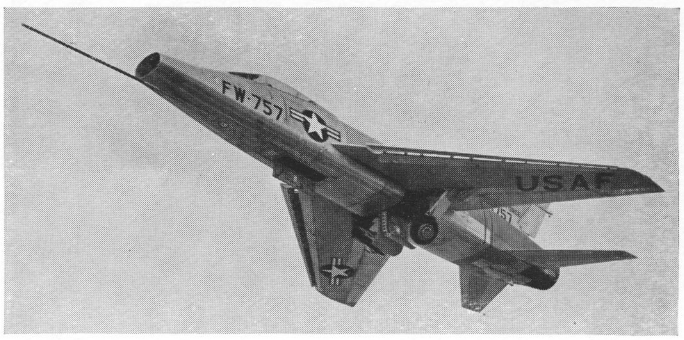
(Above) *The YF–100, prototype Super Sabre (52–5754).*



(Above) *An early production F–100A–1–NA (52–5761).*



(Above) *F–100A Super Sabre (52–5761).*



(Above) *F–100A Super Sabre (52–5757) and* (below) *(53–1529).*

Possessing the distinction of being the first combat aircraft able to fly at supersonic speeds for sustained periods to enter service with *any* air force, the North American F–100A Super Sabre single-seat air superiority fighter and fighter-bomber represents a very considerable technical advance over contemporary service fighters.

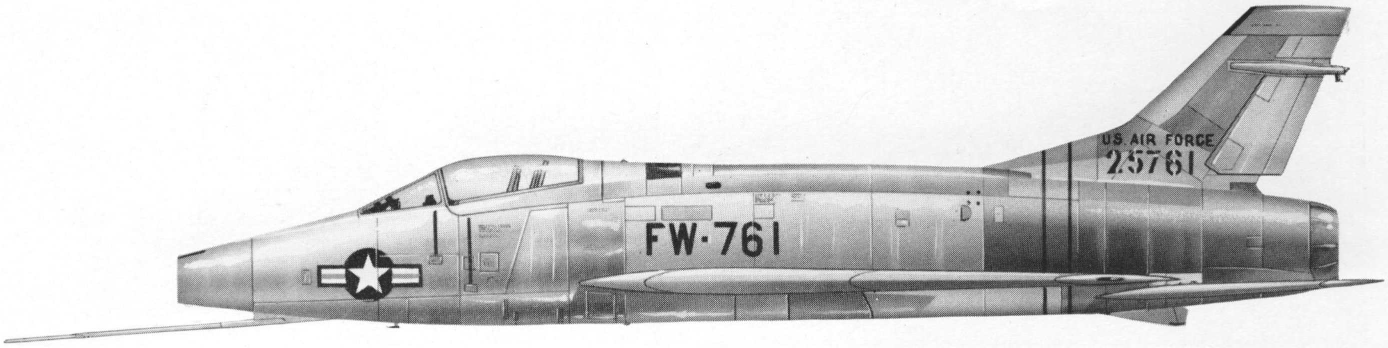
The appellation Super *Sabre* is misleading as the F–100A is a lineal descendant of the F–86 Sabre and not a development of the earlier fighter design. Developed initially as a private venture, the prototype Super Sabre, the YF–100, flew for the first time on May 25, 1953, and differed externally from the F–100A production model in having taller vertical-tail surfaces of higher-aspect ratio embodying a tall, narrow-chord rudder. On October 29, 1953, the YF–100 established a new World Air Speed Record with an average speed of 755·149 m.p.h., attaining 767·276 m.p.h. on one run. Early in its flight-test programme the YF–100 attained a Mach number of 1·38 at 35,000 ft. (913 m.p.h.). The first production F–100A Super Sabre was completed on October 20, 1953, and the first fighter squadrons of the U.S.A.F. Tactical Air Command began re-equipping with the new fighter a year later, in October 1954, less than eighteen months after the first flight of the prototype.

The F–100A possesses an extremely thin wing, which is swept at an angle of 45° at the leading edge and has a span and gross area of 36 ft. 7 in. and 376 sq. ft. respectively. The wing is mounted well aft on the exceptionally large, broad, flattened fuselage, which has a length of 45 ft. 2½ in. The vertical tail surfaces appear disproportionately small, and overall height is 14 ft. 5 in. The F–100A's control system is noteworthy. Two-section inboard ailerons replace the more conventional wing-tip ailerons which would impose severe twisting loads on the sharply swept wing, and full-span automatic slots are fitted along the leading edge. A thin, one-piece tail surface is positioned at the base of the rear fuselage, presumably avoiding the disturbed wake of the wing, and a diminutive rudder is fitted. All control surfaces are hydraulically powered, and they are claimed to enable the F–100A to manoeuvre at supersonic speeds. A large air brake is fitted below the fuselage.

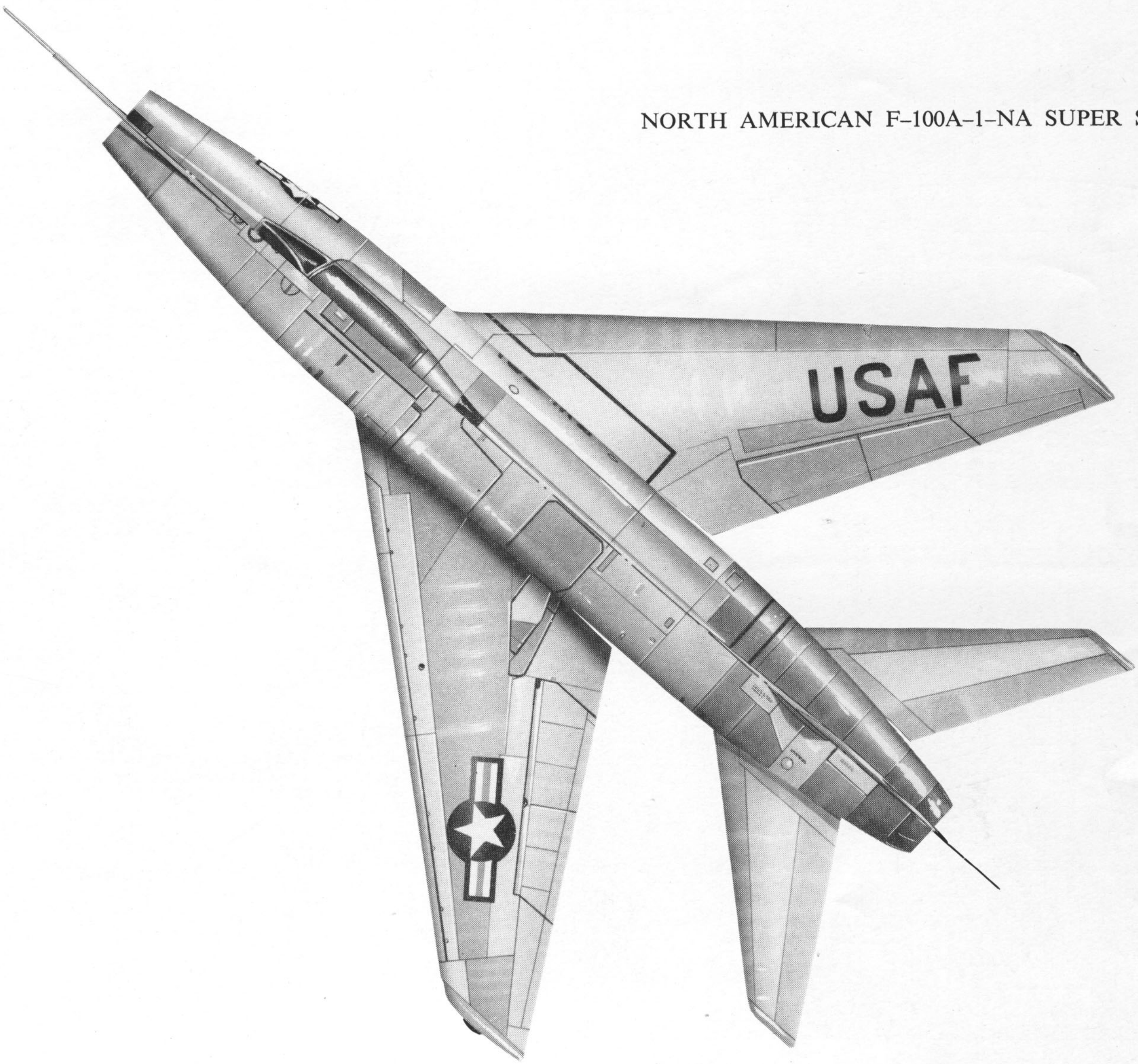
A wide, flattened pitot-type air intake bifurcates past the pilot's cockpit to feed the single Pratt & Whitney J57–P–7 turbojet, which provides 9,500 lb. thrust. This can be increased to 14,250 lb. thrust by means of afterburning. All fuel tanks are housed in the fuselage, providing a total of some 850 Imp. gal., sufficient for a normal combat radius exceeding 575 miles. Internal tankage can be augmented by four specially designed jettisonable underwing tanks providing a further 830 Imp. gal. with which combat radius is increased to approximately 1,100 miles. The two inboard auxiliary tanks are attached to specially designed pylons which extend forward to keep the weight of the fuel close to the fighter's centre of gravity. The outboard tanks are streamlined for high-speed operation, and it is to be presumed that the inboard tanks are used for take-off, climb and early cruising flight, and are then jettisoned for flight at higher speeds.

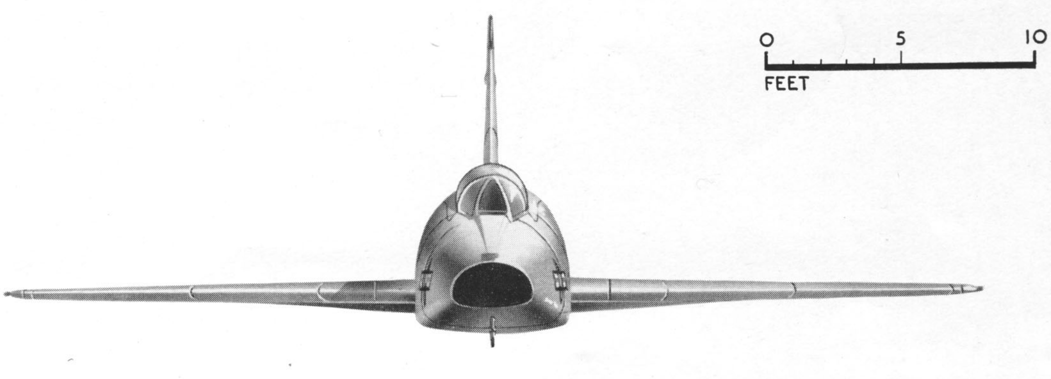
The F–100A carries an armament of four 20-mm M–39 cannon in a fuselage-bay, and underwing attachment points are provided for four 500-lb., 750-lb., 1,000-lb., or two 2,000-lb. bombs, four 750-lb. Napalm tanks, or pods containing forty-five 2·75-in. Mighty Mouse folding-fin rockets. Normal loaded weight is approximately 23,000 lb., and maximum overload weight approaches 30,000 lb. Service ceiling exceeds 50,000 ft., and maximum speed is approximately Mach 1·3 at 45,000 ft. (860 m.p.h.) and 750 m.p.h. at sea level. Initial climb rate is some 10,000 ft./min.

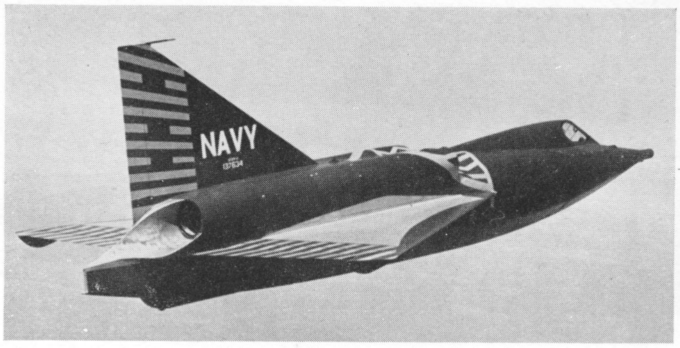
Several versions of the Super Sabre are being developed, in addition to the F–100A which is in quantity production at North American's Los Angeles factory. The F–100B is a specialised day superiority fighter, which has been redesignated F–107. The F–107 will have a thinner wing than that of the F–100A, a later J57 turbojet up-rated to 15,000 lb. thrust without afterburner thrust augmentation, a nose radome for all-weather operation and an air-to-air missile armament. The F–100C is a fighter-bomber with a strengthened wing capable of carrying heavier underwing ordnance loads, and the F–100D is an improved version of the F–100A, which is in production at North American's Columbus, Ohio factory. The TF–100 is a projected conversion trainer variant, with tandem seating for pupil and instructor in a slightly lengthened fuselage, reduced armament and fully duplicated controls.

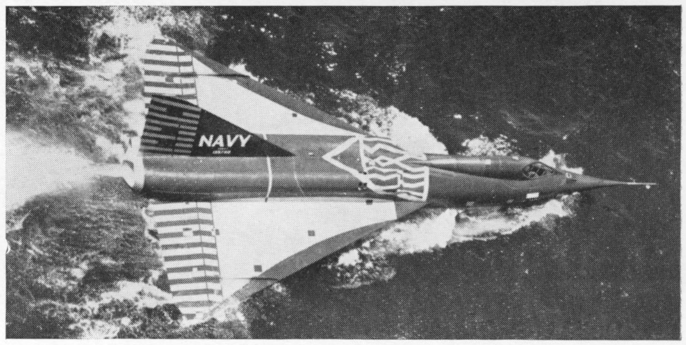


NORTH AMERICAN F–100A–1–NA SUPER SABRE

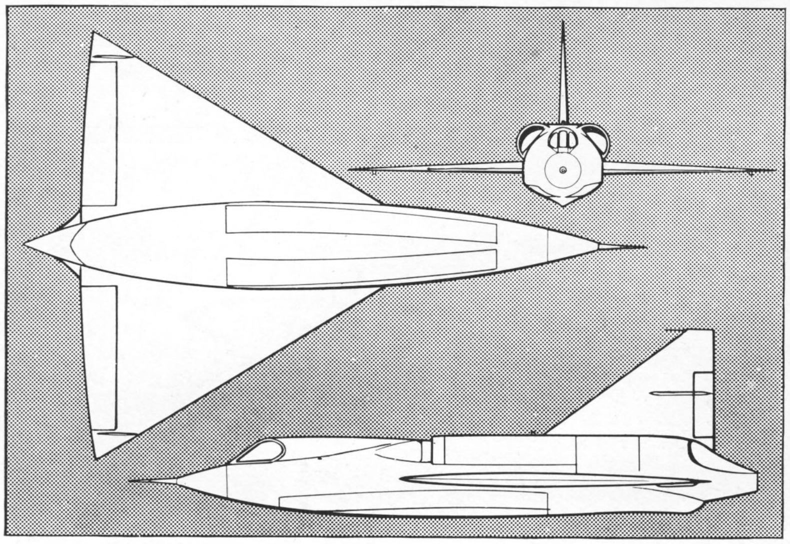








(Above, left and g.a. drawing) *The XF2Y–1 Sea Dart and* (above, right) *the YF2Y–1 with afterburning J46S.*

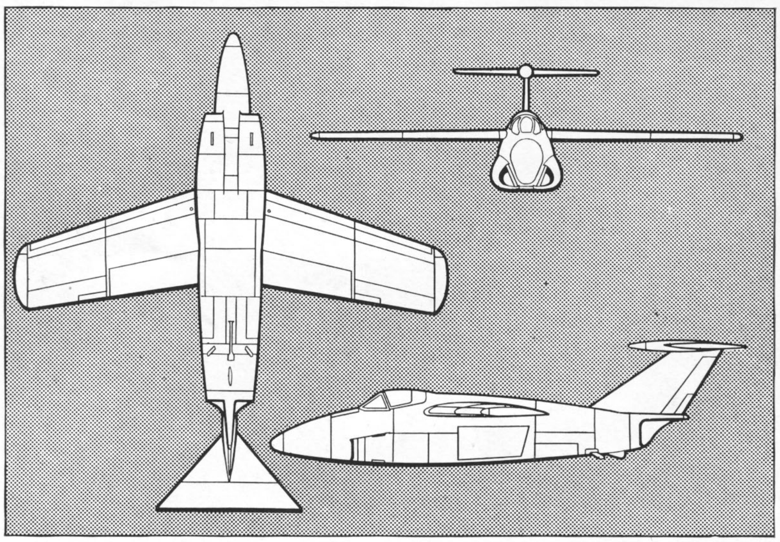


CONVAIR SEA DART (APRIL) 1953

Developed and built for the U.S. Navy Bureau of Aeronautics, the Sea Dart is the first water-borne aircraft of delta-wing planform and the first combat-type aircraft to be equipped with retractable hydro-skis (V-shaped planing surfaces). The first prototype Sea Dart, the XF2Y-1, was launched in San Diego Bay on December 16, 1952, and after extensive taxying trials flew for the first time on April 9, 1953.

The XF2Y-1 is powered by two 3,400 lb. thrust Westinghouse J34-WE-42 turbojets. The second prototype, the YF2Y-1 which was destroyed in November 1954, differed in having an extended rear fuselage to accommodate afterburners with which its two Westinghouse J46-WE units each provided 6,000 lb. thrust. Without afterburning, each J46 had a thrust rating of 4,600 lb. Initial contracts called for the production of twelve F2Y-1 Sea Dart fighters, but these were cancelled and further development is centred on a redesigned model, the XF2Y-2, which will have a single turbojet (either the 12,000 lb. thrust Wright J67 or the 15,000 lb. thrust Pratt & Whitney J75). The XF2Y-1 is now fitted with a single hydro-ski for comparison with the earlier dual hydro-ski arrangement.

The Sea Dart rests on the water in a flat position, and when sufficient speed is attained the hydro-skis provide sufficient hydrodynamic lift to raise the aircraft from the water where it planes on the skis for take-off. Take-off run is 5,500 ft. and landing run is 1,000 ft. The YF2Y-1 exceeded Mach 1·0 in a shallow dive at 34,000 ft. on August 3, 1954. Loaded weight is some 22,000 lb., and dimensions are: span, 30 ft. 6 in.; length, 41 ft. 2 in.; height (hydro-skis extended), 21 ft. 1 in.



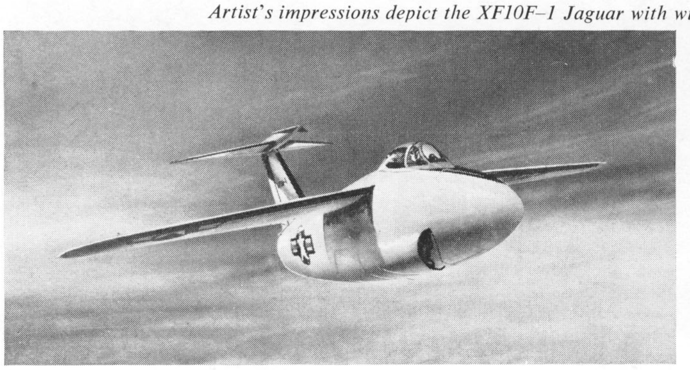
GRUMMAN JAGUAR (MAY) 1953

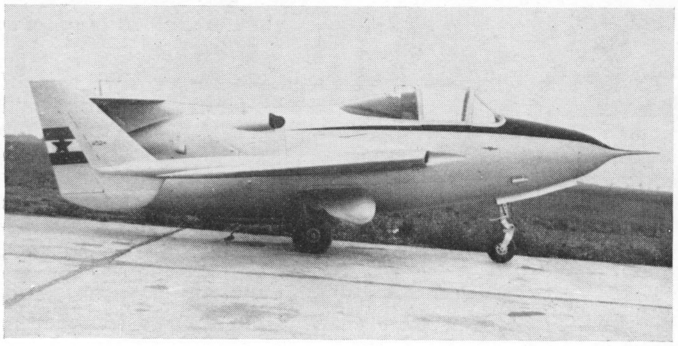
While the swept wing has been widely adopted for high-speed flight, its low-speed characteristics leave much to be desired. Good low-speed characteristics are particularly desirable in carrier-based aircraft, and an interesting attempt to provide a deck-landing fighter that would handle well at speeds within the limits imposed by carrier operations and yet be capable of attaining transonic speeds is represented by the Jaguar.

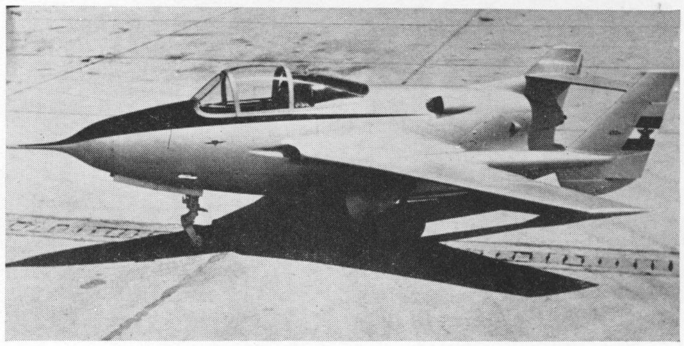
The Jaguar featured a variable-sweep wing, the sweepback angle of which could be moved through approximately 40° in flight, the operating mechanism compensating for the resultant shift of the centre of gravity. At minimum sweep angle wing span was 50 ft. 7 in., reducing to 36 ft. 8 in. with maximum sweep. The Jaguar possessed a fuselage length of 55 ft. and embodied a special aerodynamically balanced high-speed control system with a delta-planform tailplane mounted at the tip of the fin and rudder assembly.

Powered by a 7,200 lb. thrust Westinghouse J40-WE-8 turbojet which, with afterburning, delivered a total thrust of 11,600 lb., the Jaguar weighed 33,000 lb. and possessed a maximum speed of 722 m.p.h. The prototype flew for the first time on May 19, 1953, and previously the U.S. Navy had placed an order for a pre-production batch of thirty F10F-1 Jaguars. However, flight testing of this large and complicated fighter made necessary numerous modifications, including the replacement of the tip-mounted tailplane with a more orthodox assembly, but the characteristics of the Jaguar remained unsatisfactory and further work on the pre-production batch of F10F-1 fighters was abandoned.

Artist's impressions depict the XF10F–1 Jaguar with wing at minimum sweep angle and with high-set tailplane.







The unorthodox Type 452M research aircraft with superimposed turbojets.

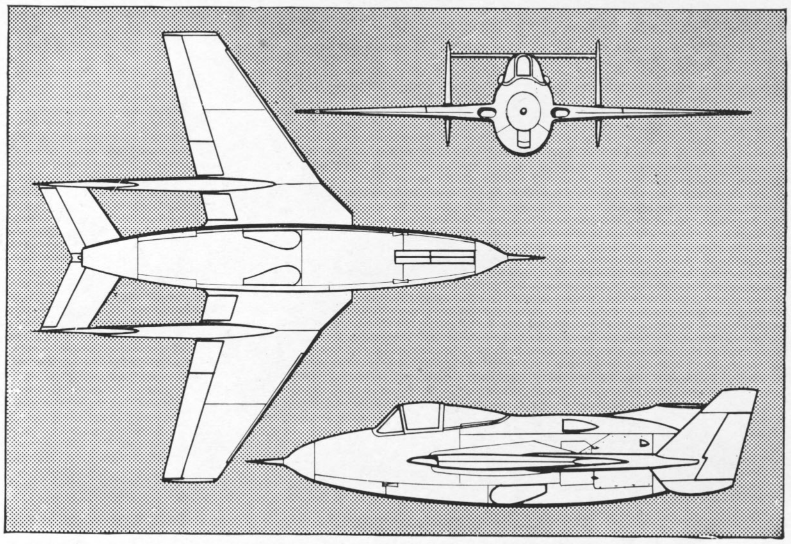
TYPE 452M (JULY) 1953

The Type 452M, the second jet-propelled aircraft to be designed in Yugoslavia, was of extremely unorthodox conception. Basically a single-seat swept-wing monoplane with twin tail booms, the vertical tail surfaces carried an unusual Vee-shaped tailplane, supported at the centre by an auxiliary fin attached to the rear of the fuselage nacelle.

The first of two prototypes flew for the first time on July 24, 1953, and was intended to provide data for a light ground-support and high-speed liaison aircraft.

Of all-metal construction and built by the Ikarus factory at Zemun, near Belgrade, the Type 452M was powered by two Turboméca Palas turbojets of 330 lb. thrust, superimposed one above the other in the rear of the fuselage nacelle. Each turbojet was fed by an individual pair of air intakes, those for the lower Palas being disposed in the wing roots and those for the upper unit being positioned on the upper fuselage, aft of the cockpit canopy. A retractable nosewheel undercarriage of exceptionally narrow track was fitted, and the wing leading edge was swept at an angle of 40°.

The dimensions of the Type 452M were extremely small, span and length being 17 ft. 2½ in. and 19 ft. 7 in. respectively. Despite the low power of the two Palas turbojets, a maximum speed of 484·6 m.p.h. was attained. Loaded weight was 2,337 lb. The Type 452M was designed by Major Dragoljub Beslin, assisted by engineers Levacic and Kostic.

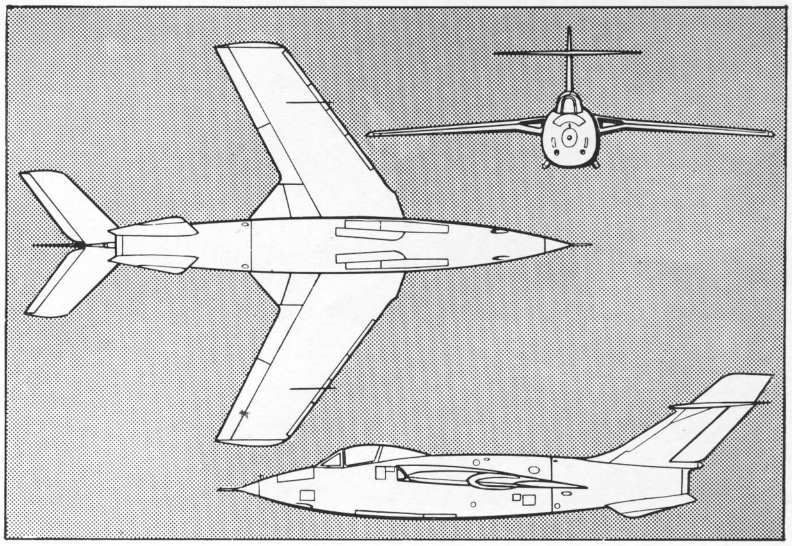


SUD-EST BAROUDEUR (AUGUST) 1953

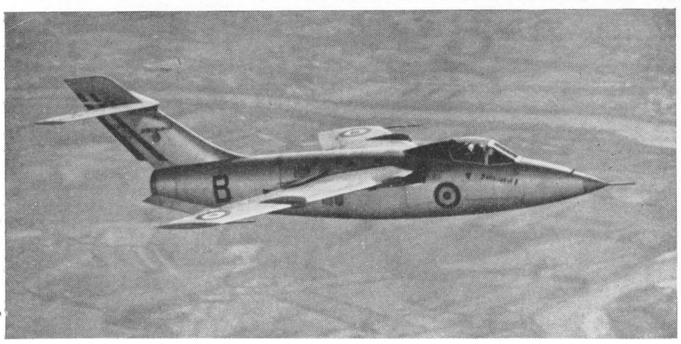
The S.E.5000 Baroudeur was designed to operate from small, semi-prepared, advanced bases and, in order to operate from fields of only 750 yds. length, reverts to the use of a jettisonable take-off trolley and landing skids as employed by the German Arado Ar 234A and Messerschmitt Me 163B aircraft. For take-off, two or four rockets are attached to the trolley which is automatically braked once the aircraft has left the ground.

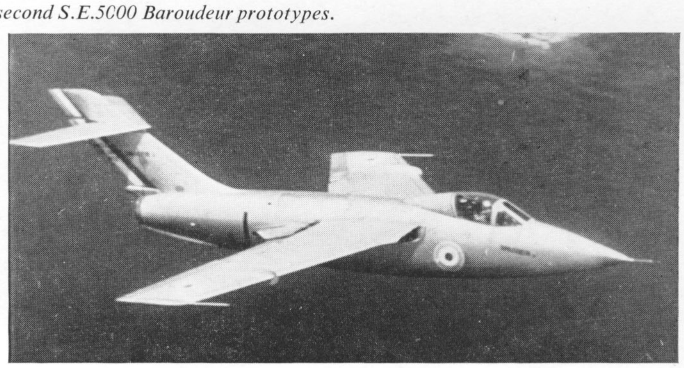
The first prototype Baroudeur, the S.E.5000-01, powered by a 5,280 lb. thrust SNECMA Atar 101B turbojet, flew on August 1, 1953, and the second prototype, the S.E.5000-02, was powered by a 6,170 lb. thrust Atar 101C with which it attained a maximum speed of 646 m.p.h. at 19,685 ft. The second prototype weighed 9,854 lb. empty and 13,889 lb. loaded. Three pre-production Baroudeurs are currently under construction, and these will be powered by the 7,280 lb. thrust Atar 101E turbojet with which maximum speeds of 709 m.p.h. at sea level and 700 m.p.h. at 19,685 ft. are anticipated. Estimated initial climb rate is 10,500 ft./min., and normal and maximum loaded weights will be 15,256 lb. and 20,018 lb.

Three versions of the Baroudeur are projected for interceptor, ground support and escort roles, and fixed armament will comprise two 30-mm. Hispano 603 cannon. Various underwing ordnance loads will be carried. The Baroudeur can take off on its skids without the aid of the trolley, and can also fly with the trolley attached. Overall dimensions are: span, 32 ft. 10 in.; length, 44 ft. 3 in.; wing area, 272 sq. ft.

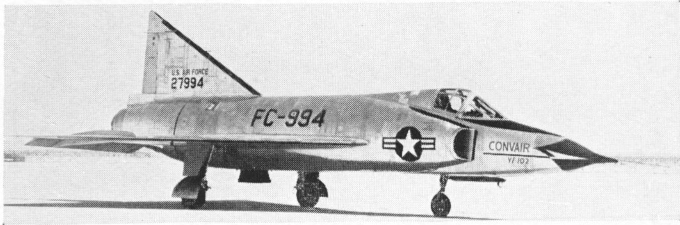


(Below, left) *The first and* (below, right) *second S.E.5000 Baroudeur prototypes.*

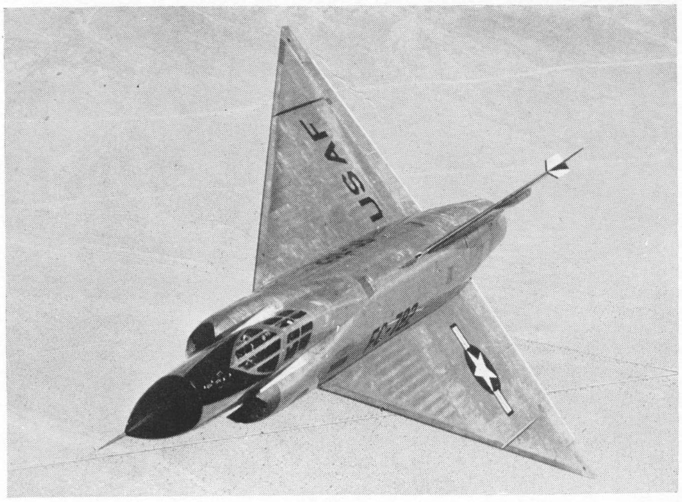




CONVAIR F-102A



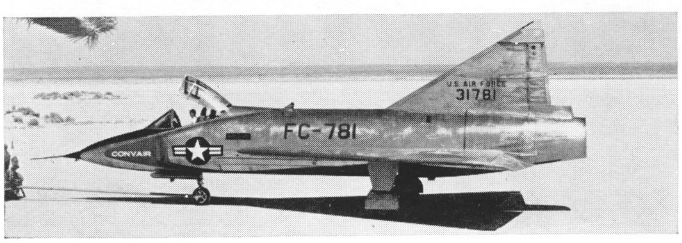
(Above) *First prototype YF–102 (52–7994).*



(Above) *Early production F–102A (53–1782).*

(Above) *Convair F–102A (53–1782).*

(Above) *Convair F–102A (53–1782) and* (below), *(53–1781).*



The F–102A single-seat all-weather interceptor fighter is of extremely advanced design and, intended for eventual production as a remotely-controlled pilotless interceptor, may mark the beginning of the transition from piloted fighters to remotely controlled aircraft for bomber interception.

Development of the design commenced in 1951, and early in 1952 a U.S.A.F. contract was placed for two prototypes designated YF–102. Design work was based on experience gained with the XF–92A research aircraft which was, itself, a flying model of an earlier delta-wing fighter project. The first YF–102 was flown on October 24, 1953, but was destroyed in an emergency landing a week later, on November 2. The second YF–102 first flew on January 11, 1954, and was followed in March by the first production F–102A, initial contracts for some thirty F–102As having been placed in 1953.

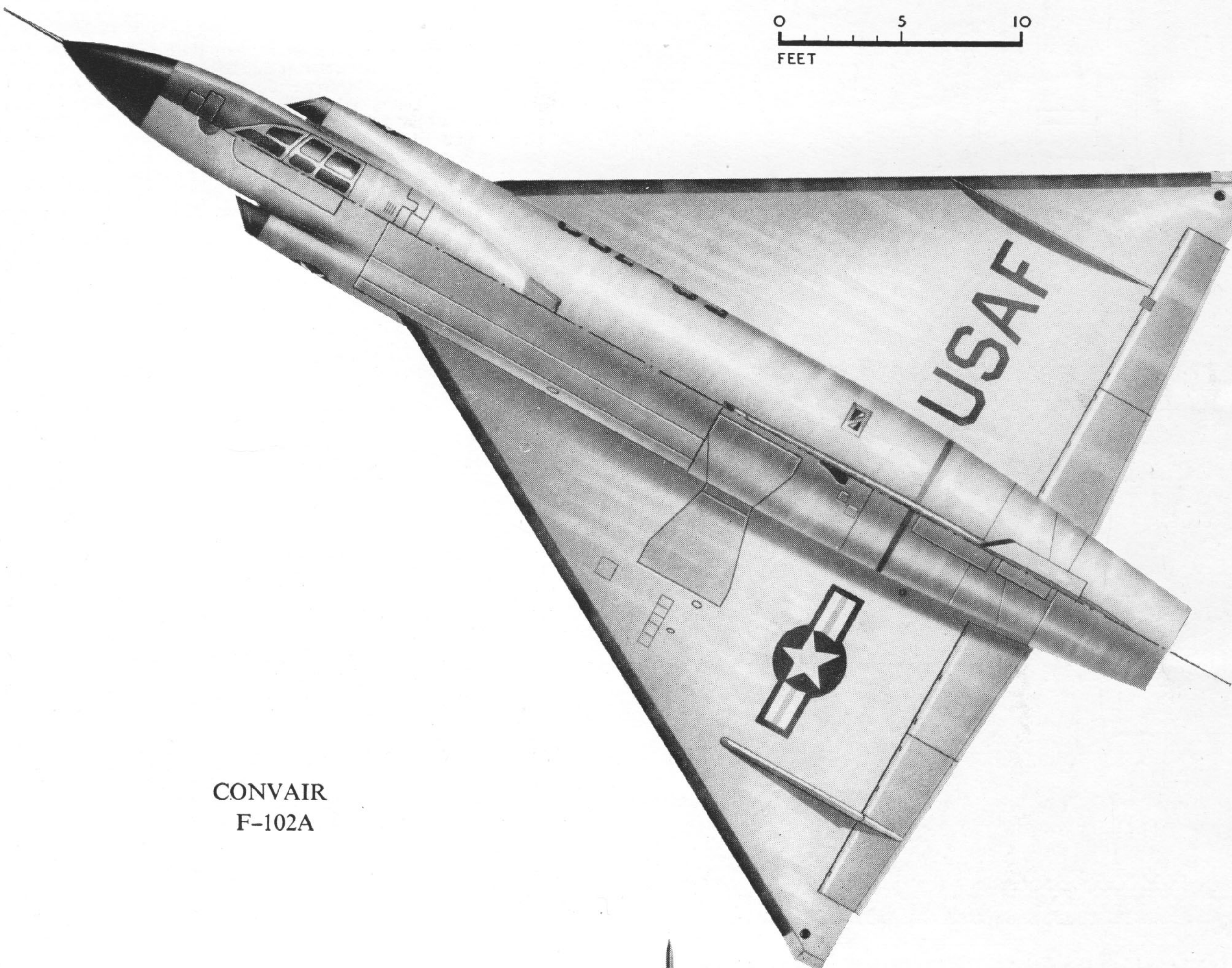
The F–102A makes interesting comparison with the British Gloster Javelin fighter, as they exemplify the divergent views on delta-wing planforms held by American and British designers. Whereas the F–102A possesses a wing with a thickness/chord ratio of only some 5 per cent, all armament, fuel tanks, undercarriage, etc., being housed in the fuselage, British designers favour housing the bulk of this equipment in a fairly thick wing envelope. The wing of the F–102A is so thin that the control elements must be contained in external fairings. Leading-edge sweep angle is 60° and span is 38 ft. The trailing edge carries powered elevons for lateral and longitudinal control. Gross wing area is 660 sq. ft.

The F–102A possesses no horizontal tail surface, and it is to be presumed that the large root chord provides adequate damping in pitch. Like the wing, the large vertical tail surface is of extremely thin section, and control elements are housed in external fairings. The large, circular-section fuselage is 52 ft. 5 in. long. The nose section houses a complex Hughes automatic electronic guidance system which, employed in conjunction with missiles, locates and locks on to the target, aims and launches the air-to-air rockets. The pilot is seated well forward in the fuselage nose beneath a sharp-edged canopy which is spring-loaded, and in an emergency can be released, whereupon it is forced up at the front by the airstream to allow clearance for the ejector seat.

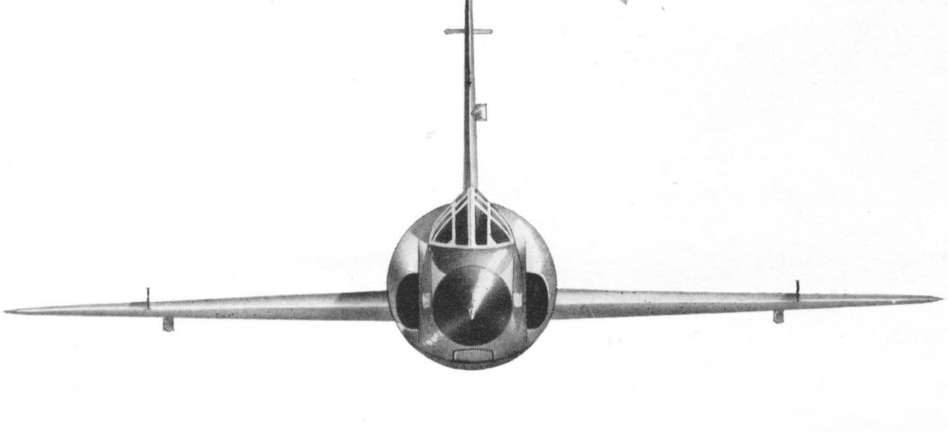
Aft of the pilot's cockpit, the lower fuselage houses a retractable armament bay containing Hughes F–98 Falcon self-homing air-to-air missiles. Additional F–98 missiles can be carried either underwing or pick-a-back. Reference has been made to the designation DF–102A for the missile-equipped aircraft (the "D" denoting "director" fighter). The Pratt and Whitney J57–P–11 turbojet is rated at 10,900 lb. thrust, and has an afterburner extension which increases thrust to 15,000 lb. With afterburner in use, the F–102A can attain level speeds in the vicinity of Mach 1·5 at high altitude. Maximum speed at sea level (without afterburning) is 739 m.p.h. Service ceiling is 60,000 ft., and, in keeping with its short-range interceptor role, the operational range is only some 500 miles. The approximate loaded weight of the F–102A is 25,750 lb., but in maximum overload condition it is likely to be 30,000–32,000 lb.

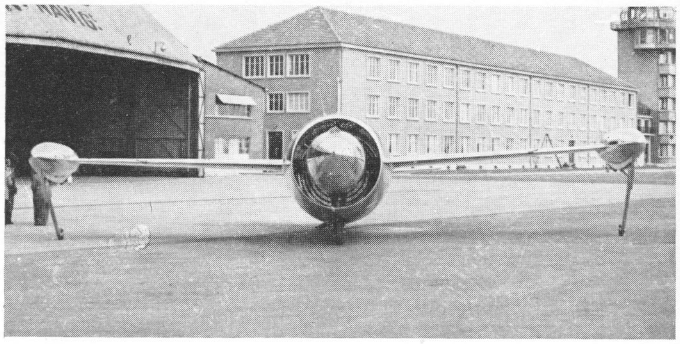
Further developments of the basic design include the TF–102 and the F–102B. The TF–102 is a conversion trainer variant of the F–102A fighter intended for the training of pilots in the handling characteristics of delta-wing aircraft. The twenty TF–102s ordered will be powered by the Pratt and Whitney J57 turbojet and will have side-by-side seating for the instructor and pupil. The F–102B is considered to be the ultimate piloted development of the design and is intended to attain speeds up to Mach. 2·0 in level flight. The F–102B will be powered by a Wright J67–W turbojet (a two-spool unit based upon the British Bristol Olympus but having a greater mass flow than the present British engine) initially providing 12,000 lb. thrust, which will ultimately be augmented by afterburning to a total thrust of 25,000 lb. An alternative turbojet under consideration is the Pratt and Whitney J75 which is expected to give a basic thrust of 15,000 lb. and up to 21,000 lb. thrust with afterburning.

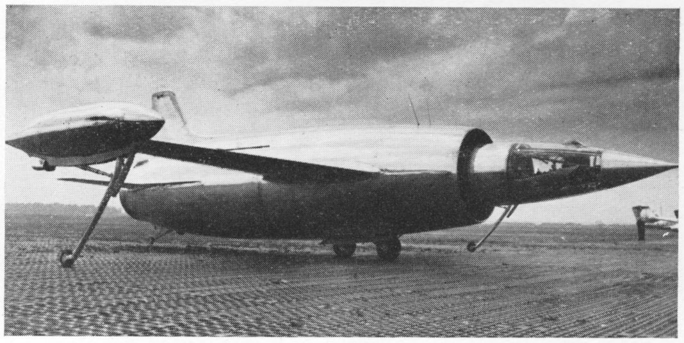
It is of interest to note that Convair has chosen a generally similar overall configuration to that of the F–102 for the supersonic XB–58 Hustler long-range medium bomber. The XB–58 is to be powered by eight General Electric J79–GE turbojets of 15,000 lb. thrust which will be mounted semi-externally in the thin wing.



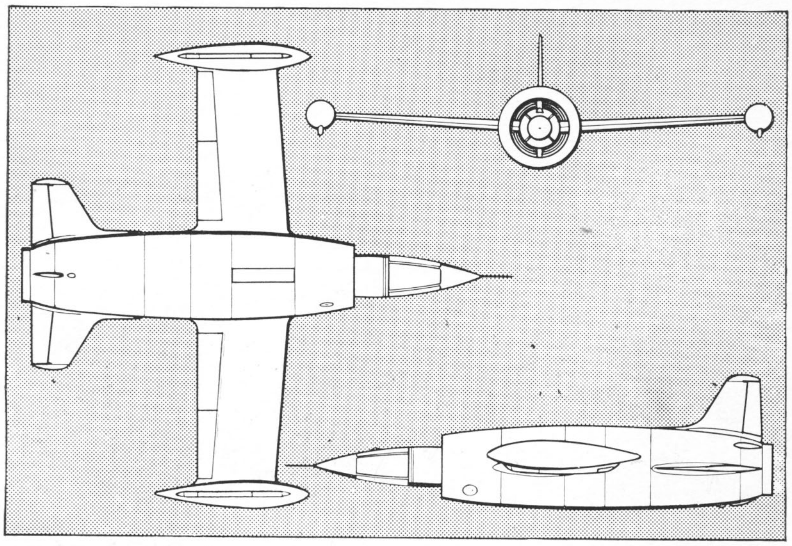
CONVAIR
F–102A







The Leduc 021–01 prior to the fitment of auxiliary turbojet for stand-by power.

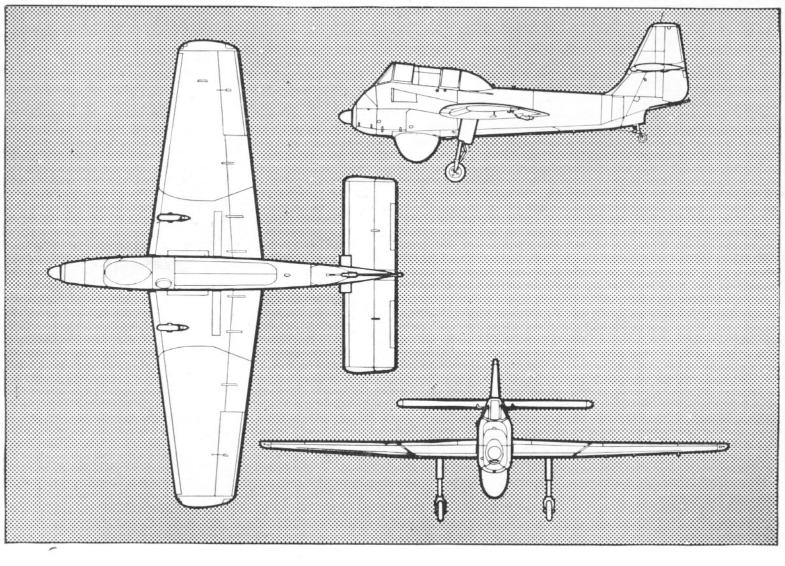


LEDUC 021 (AUGUST) 1953

Like the Leduc 010 and 016 from which it is derived, the Leduc 021 is a subsonic test vehicle for its ramjet power plant. It is also employed to provide operational data for the supersonic Leduc 022 which is being built to full fighter requirements. The latter aircraft will differ from the Leduc 021 primarily in having a S.N.E.C.M.A. Atar 101 turbojet installed aft of the cabin *inside* the ramjet duct to provide static thrust, and sweep-back on the wing and tail surfaces.

The Leduc 021–01 was completed early in 1953 and initial air tests commenced in May of that year with the research aircraft mounted above an S.E.161 Languedoc transport. The first powered flight was made on August 7, 1953. A second machine, the Leduc 021–02, flew under its own power for the first time on March 1, 1954. Like the earlier research machines, the Leduc 021 is limited to Mach 0·85, at which speed the ramjet develops a thrust of 13,200 lb. After the completion of its initial flight-test programme, the Leduc 021–01 was fitted with a Turboméca Marboré II turbojet of 836 lb. thrust in the ramjet duct. This auxiliary unit is intended to provide standby power for landing.

The Leduc 021 is intended for research at altitudes between 33,000 and 66,000 ft., and initial climb rate is 39,420 ft./min., which falls off to 2,900 ft./min. at 49,000 ft. A total of 630 Imp. gal. of fuel is carried, providing a flight endurance of 15 min. to 1 hr. according to altitude, and empty and loaded weights are 8,350 lb. and 13,200 lb. respectively. Dimensions are: span, 38 ft. 1 in.; length, 41 ft. 1 in.; height, 9 ft.; wing area, 238 sq. ft.



SHORT SEAMEW A.S.1 (AUGUST) 1953

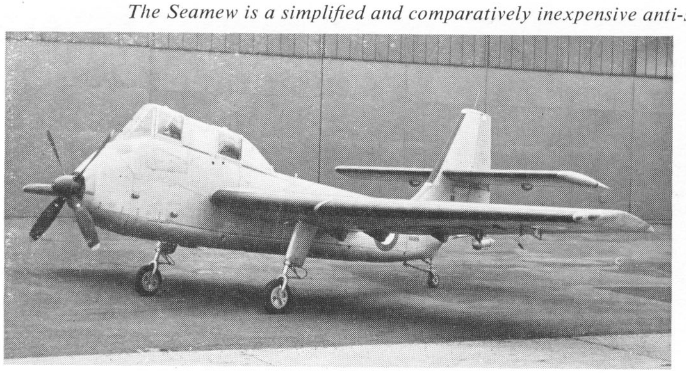
Intended to perform duties currently undertaken by considerably more elaborate and costly aircraft, the Short S.B.6 Seamew ship-borne anti-submarine aircraft is a highly simplified aircraft reduced to the smallest number of essential components. Designed, built and flown in little more than seventeen months, the Seamew carries full search and strike radar and a substantial internal warload. Extensive simplification of structure and weight-saving has resulted in a normal loaded weight of only some 14,000 lb. without penalising the strength factor.

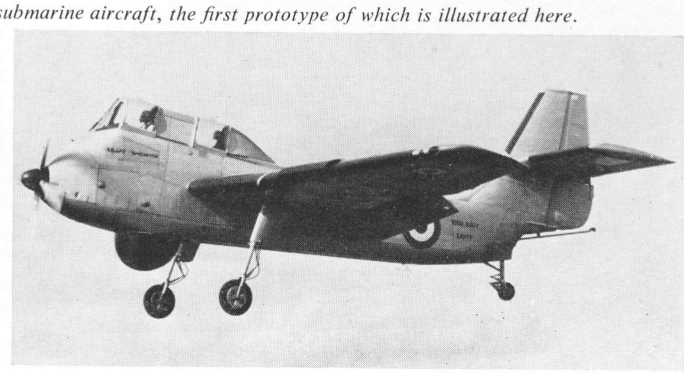
The first prototype Seamew flew on August 23, 1953, powered by a 1,320 e.s.h.p. Armstrong Siddeley Mamba A.S.Ma.3 turboprop, and was followed by a second prototype powered by the 1,590 s.h.p. Armstrong Siddeley Mamba A.S.Ma.6 unit, which will also power the production Seamew A.S.1.

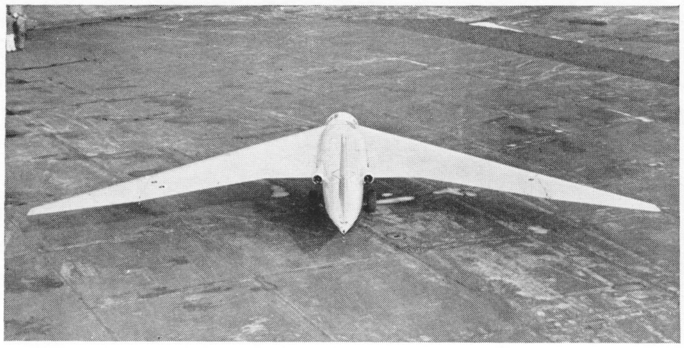
The Seamew was designed to operate from small escort carriers, but is suited for inshore maritime patrol from small semi-prepared coastal strips. The forward-positioned cockpit provides the pilot with an exceptional view, and a search radome is attached to the underside of the front fuselage giving a 360° sweep in azimuth. In addition to the bombs or depth charges housed internally in the 14-ft. bomb-bay, sonobuoys or additional ordnance can be carried on underwing racks. The wing is power-folded for carrier stowage and the undercarriage is fixed.

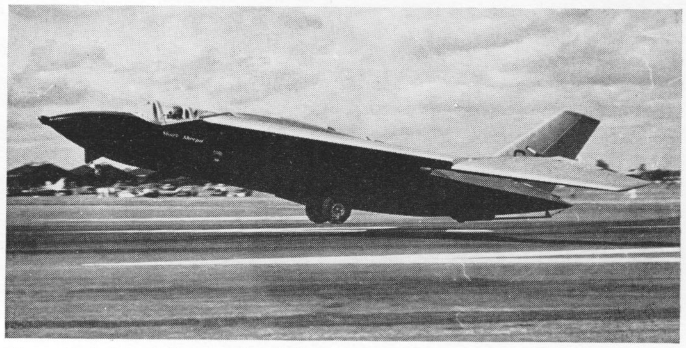
Exceptional low-speed characteristics and the ability to cruise at low speed for considerable periods are ideally suited for the Seamew's anti-submarine role. Overall dimensions are: span 55 ft., length 41 ft., height 16 ft. 4 in.

The Seamew is a simplified and comparatively inexpensive anti-submarine aircraft, the first prototype of which is illustrated here.



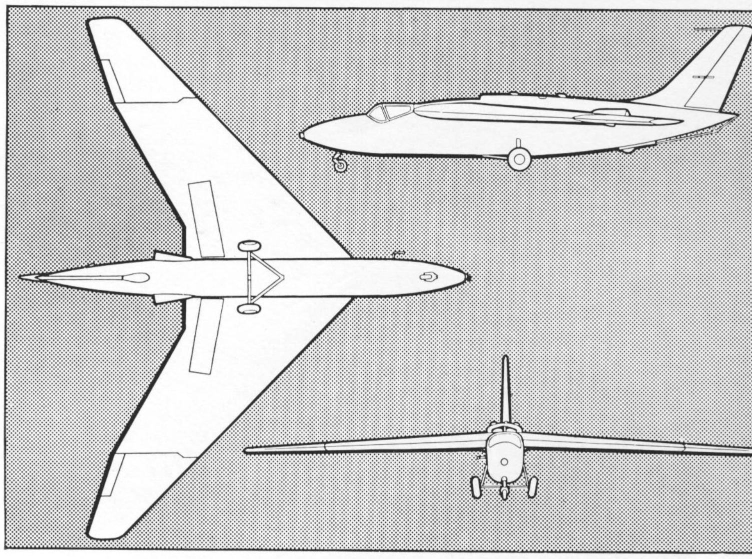






The Short S.B.4 Sherpa was built to test the characteristics of the aero-isoclinic wing.

SHORT S.B.4 SHERPA (OCTOBER) 1953

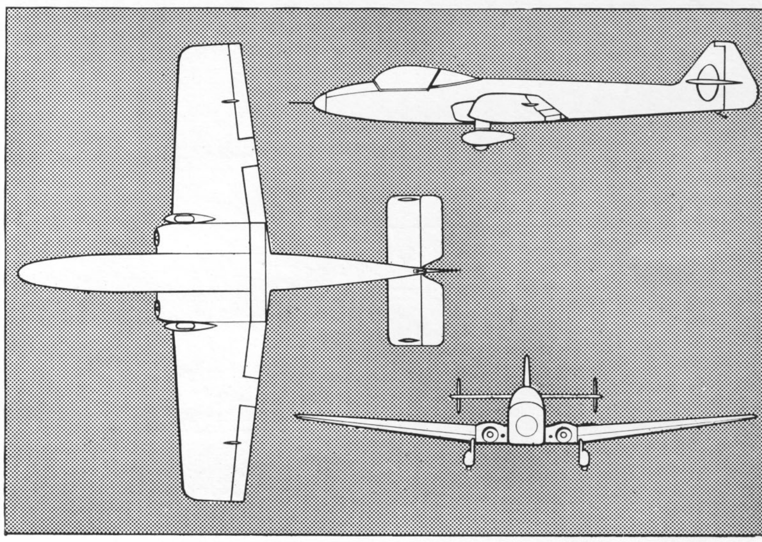


The first aeroplane built to investigate the aero-isoclinic wing, in which incidence remains constant regardless of wing flexing, the S.B.4 Sherpa single-seat research aircraft was flown for the first time on October 4, 1953. The Sherpa is powered by two 353 lb. thrust Blackburn-Turboméca Palas turbojets mounted side by side over the wing trailing edge and fed via a common air intake aft of the pilot's cockpit. The two Palas units provide an operating speed range of 117-170 m.p.h. and sufficient fuel is carried to permit an endurance of 50 min. at 117 m.p.h. at 10,000 ft.

The aero-isoclinic wing has been developed to overcome the loss of incidence at the tips suffered by swept wings under bending loads and the resultant dynamic instability. This form of instability is overcome in the aero-isoclinic wing by placing the wing torsion box as far aft in the section as is practicable and reducing the torsion stiffness so that the wing twists under load sufficiently to counterbalance the loss of incidence due to bending. Rotating wing-tips combining the function of aileron and elevator are pivoted about a line approximately through the centre of pressure and impose little torsion on the rest of the wing. The rotating wing-tip control surfaces make it possible to dispense with the usual tailplane and elevators. They can be rotated together or in opposition to act as elevators or ailerons respectively.

The wing of the S.B.4 Sherpa is swept 42° and has a span of 38 ft. and a wing area of 261·5 sq. ft. Length is 31 ft. $10\frac{1}{2}$ in., and height is 9 ft. $1\frac{1}{8}$ in. Loaded weight is 3,125 lb.–3,268 lb.

MILES SPARROWJET (DECEMBER) 1953



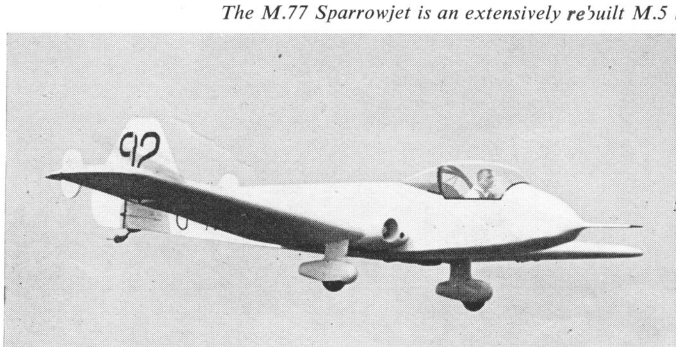
While not strictly a new design intended for turbojet power from the outset, the M.77 Sparrowjet is included here as one of the most interesting aeronautical transformations of recent years. Intended as a light racing monoplane, it is basically an extensively rebuilt 1935-vintage M.5 Sparrowhawk airframe.

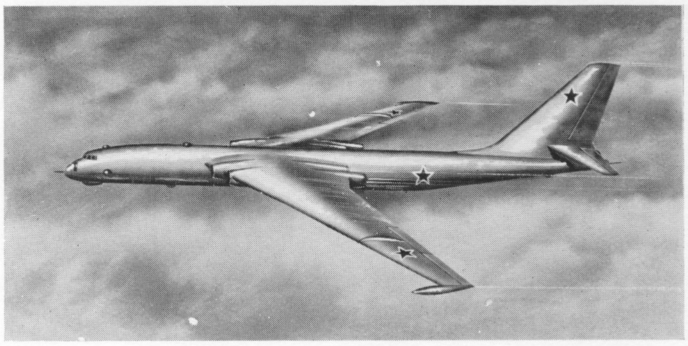
The main changes are the addition of an entirely new nose section and cockpit, and the insertion of metal engine bays between the fuselage and the original wing roots to accommodate two 330 lb. thrust Turboméca Palas turbojets. The outer wings have been used in their original form, apart from some structural strengthening and the cutting back of the wing tips, and the new forward fuselage increases overall length by 4 ft. in comparison with the original Sparrowhawk. The rear fuselage has also been reinforced and the top decking re-designed. The tailplane has been raised 6 in. to clear the jet efflux, and auxiliary vertical surfaces have been added to the tailplane.

Two 42 Imp. gal. fuel tanks installed outboard of the engine bays feed the two Palas turbojets which provide the Sparrowjet with a maximum cruising speed of 220 m.p.h. at 10,000 ft. and an initial climb rate of 2,100 ft./min. Maximum rate of climb on one engine at take-off is 485 ft./min., and the Sparrowjet can reach 10,000 ft. in 6·6 min. Empty and loaded weights are 1,578 lb. and 2,400 lb. respectively; and overall dimensions are: span, 28 ft. 7 in.; length, 30 ft. 10 in.; height, 7 ft. 2 in.; wing area, 156 sq. ft.

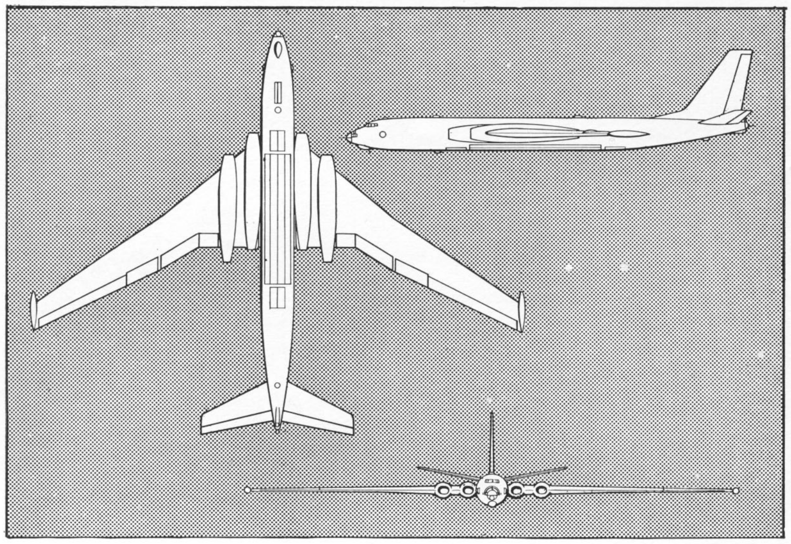
Although the structural changes between the Sparrowhawk and the Sparrowjet are relatively simple in themselves, the rebuilt aircraft now bears little resemblance to the original.

The M.77 Sparrowjet is an extensively rebuilt M.5 Sparrowhawk of 1935 vintage with twin Palas turbojets.





The photo (above, left) *of the Type 37 Bison heavy bomber was taken during the first public appearance of the machine on May 1, 1954.*

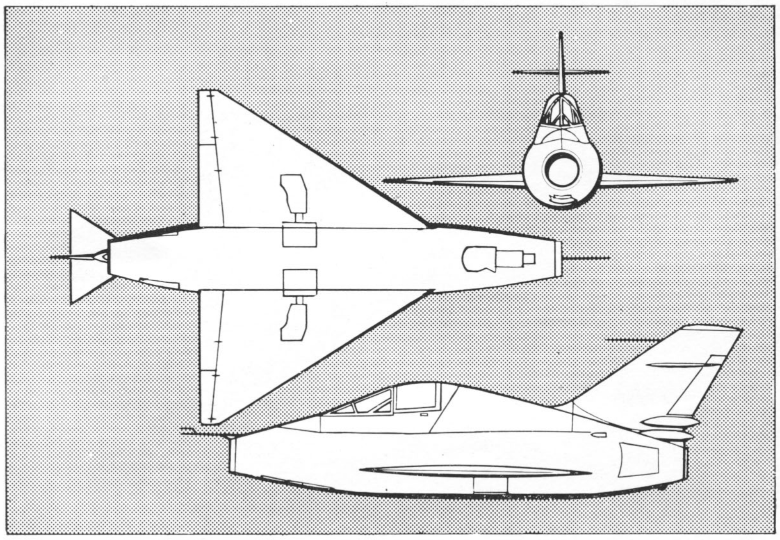


TYPE 37 (BISON) (LATE) 1953

On May 1, 1954, an extremely large jet bomber flew over Moscow during the annual May Day celebrations. This aircraft, which represents the most recent example of Russian heavy-bomber design, has been given the designation Type 37 for identification purposes by the Western armed forces, but is believed designed by Andrei N. Tupolev.

The Type 37 possesses several interesting design features which indicate its high-altitude, long-range role. The wing, which spans between 160 ft. and 170 ft., is of unusually high aspect ratio, presumably chosen for its favourable high-altitude characteristics. The major drawback of such a wing, apart from structural considerations, is its poor torsional rigidity. Torsional vibration or deformation may account for the wing-tip protuberances, which are likely to be mass balances. They may also act as housings for combustion heaters.

The wing chord is broad at the roots, and the section is sufficiently thick to allow the partial "burial" of the turbojets. The main undercarriage members are housed fore and aft of the bomb-bay. The wing centre section is swept some 40° at the leading edge, reducing to about 34° at mid-span. The turbojet nacelles are of considerable girth, their diameter being some 5 ft. and their length approximately 37 ft. The turbojet thrust has been estimated at 15,000 lb. each. The fuselage length is some 135 ft. Numerous dorsal and ventral sighting station blisters, remotely controlled turrets and radar bulges protrude, and the Type 37 is obviously intended for subsonic flight, its critical Mach number being in the vicinity of 0.95. Loaded weight is probably some 250,000 lb.



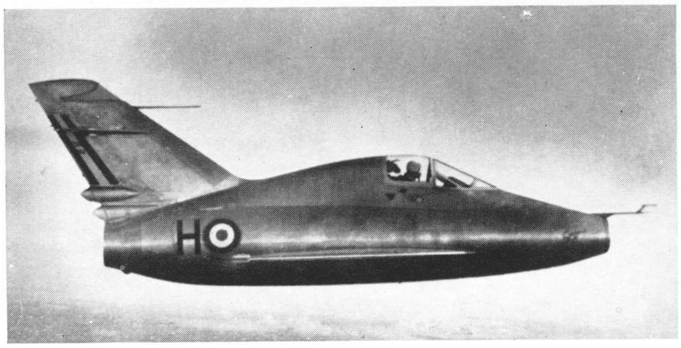
S.F.E.C.M.A.S. GERFAUT (JANUARY) 1954

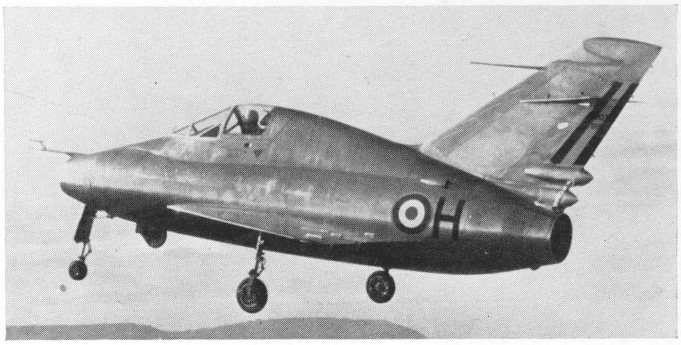
The Gerfaut, was designed to furnish data for a higher-powered single-seat fighter designated S.F.E.C.M.A.S. 1501. This will employ the same planform as the Gerfaut but will be powered by an Atar 101G turbojet of 7,275 lb. thrust and 9,260 lb. thrust with afterburning. The Gerfaut flew for the first time on January 15, 1954, and on August 3, 1954, became the first European aircraft to exceed Mach 1·0 in level flight without recourse to some form of power boosting.

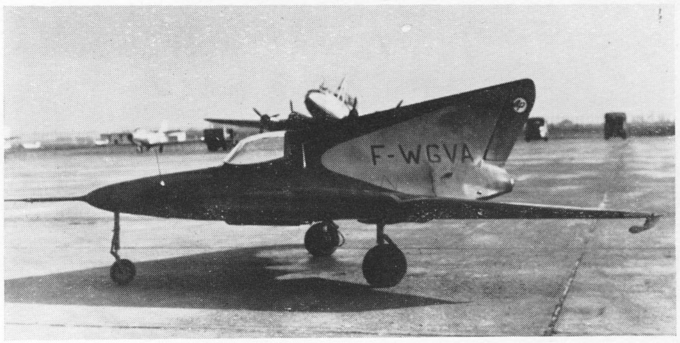
The wing employed by the Gerfaut is swept at an angle of 60° at the leading edge and is of remarkably thin section, the thickness/chord ratio being less than 6 per cent. All control surface operating levers and hinges are external. Power is provided by a S.N.E.C.M.A. Atar 101C turbojet of 6,170 lb. thrust, but the straight-through airflow arrangement—the pilot's cockpit and all fuel tanks, etc., being housed in a superstructure *above* the air duct—which obviously benefits engine performance, also lends itself to the substitution of more advanced power plants. While the humped upper-fuselage contour would seem likely to cause severe drag-producing shockwaves, an airframe limiting Mach number of 1·3 is claimed for the Gerfaut. The small delta tail is of the all-moving type, without separate elevators, and the large vertical fin compensates for the short tail moment-arm in providing adequate damping.

The Gerfaut weighs 6,327 lb. empty and 7,936 lb. loaded. Maximum speed is Mach 1·05 at 32,800 ft., and ceiling is 55,700 ft. Dimensions are: span, 21 ft. 4 in.; length, 32 ft. 5½ in.; height, 13 ft. 8½ in.; wing area, 204·514 sq. ft.

The Gerfaut was the first aircraft in the world to exceed Mach unity in level flight without power boosting.

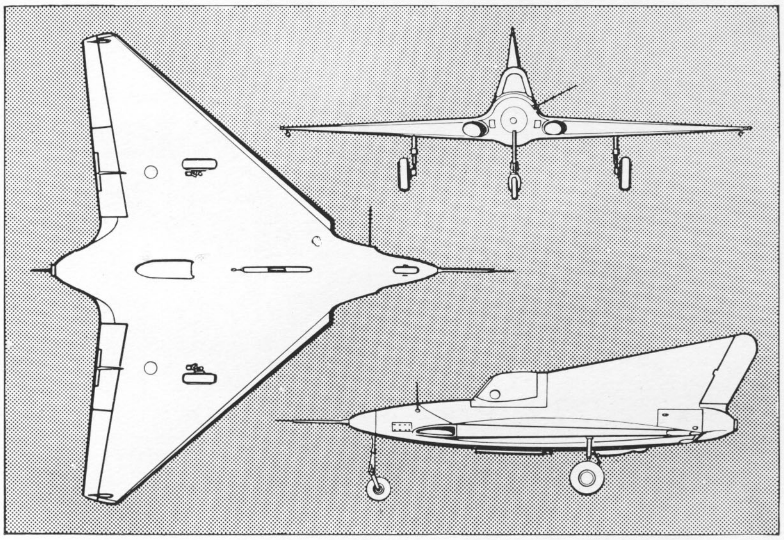






The Payen Pa 49 is a light experimental delta aircraft of all-wood construction.

PAYEN PA 49 (JANUARY) 1954



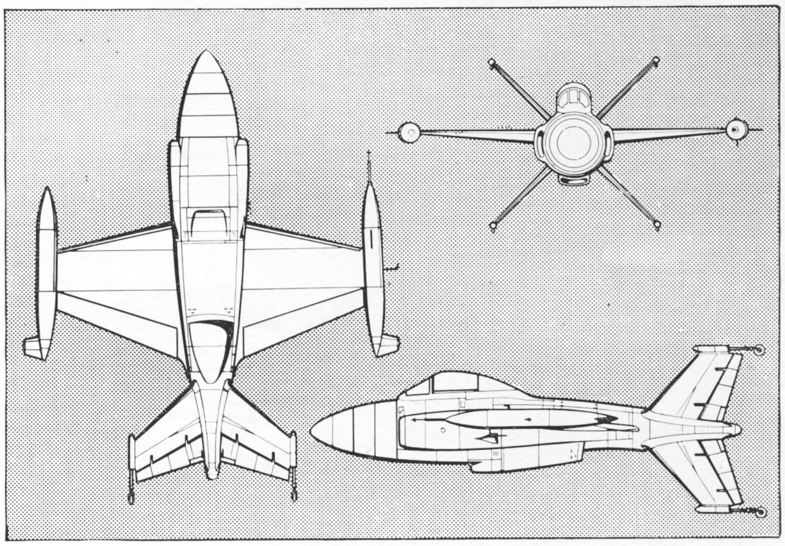
Designed by N. R. Payen, who has conducted delta-wing research for more than twenty years (his first design to embody a wing of delta planform, the Pa 100 Flechair, flying in 1934), the Pa 49 is an exceptionally small single-seat research aircraft. Design work was initiated in 1951 after a series of studies had been submitted to the French Air Ministry, and the Pa 49 flew for the first time on January 22, 1954.

Built primarily to furnish data for a projected light interceptor fighter of generally similar configuration, the Pa 49 is of all-wood construction and weighs 1,007 lb. empty and 1,433 lb. loaded. The 330 lb. thrust Turboméca Palas is housed aft of the pilot's cockpit and is aspirated by small wing-root intakes. The wing has a leading-edge sweep of 70° and has a span of 16 ft. 11 in. and an aspect ratio of 2·7. Overall length and height are 16 ft. 8¾ in. and 7 ft. 2½ in. respectively.

The Pa 49 completed the first phase of its flight testing in August 1954, and in October was fitted with split flaps for the second flight-test phase. The maximum speed of the Pa 49 is 310 m.p.h. and cruising speed is 217·5 m.p.h. Endurance is 1 hr., but this can be extended by the attachment of an auxiliary tank under the fuselage. Initial climb rate is 1,142 ft./min. and service ceiling is 27,890 ft.

Several developments of the Pa 49 have been projected, the latest being the Pa 56 Jockey two-seat trainer. The Pa 56 can be powered by a single 1,640 lb. thrust Armstrong Siddeley Viper A.S.V.5 or by two 880 lb. thrust Turboméca Marboré II, the former in the rear fuselage and the latter disposed in the wing roots. A retractable undercarriage will be fitted.

LOCKHEED XFV–I (MARCH) 1954

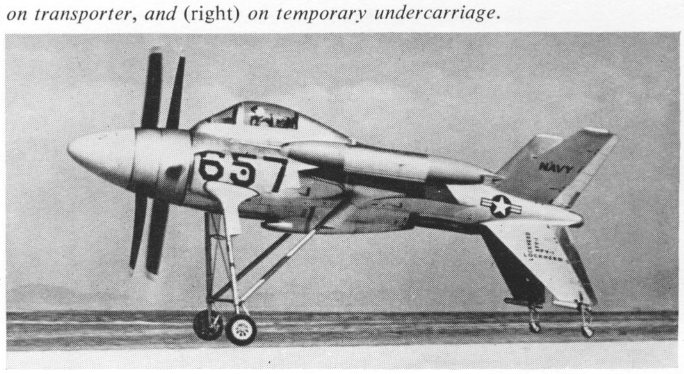


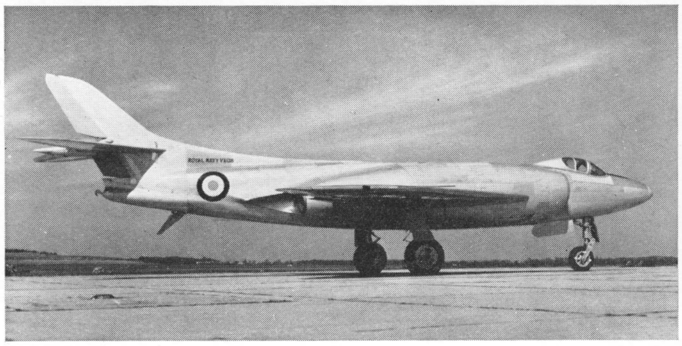
With the advent of aircraft turbojet and rocket propulsion the possibility was realised of sufficient power being made available to make practical the long-contemplated vertical take-off interceptor fighter, capable of operating from the roof of a building, a forest clearing, or the deck of a merchant ship alike.

In 1950, the U.S. Navy held a design competition for a single-seat fighter which, while capable of orthodox flight manœuvres, would possess vertical take-off and hovering characteristics. Development contracts were awarded to Lockheed and Convair, and the former company's fighter was completed early in 1954. A power-to-weight ratio of at least 1·25: 1 is necessary to enable an aircraft to achieve the thrust versus gravity manœuvre of vertical take-off, and a specially developed version of the Allison T40 turboprop was chosen to power the Lockheed XFV-1 Salmon. This unit, the YT40-A-14, provides 7,100 e.h.p. during the critical take-off period and is capable of operating satisfactorily in both the vertical and horizontal attitudes. Pending the delivery of this power plant, a 5,850 e.h.p. T40-A-6 unit was installed in the XFV-1 for horizontal flight tests which commenced in March 1954.

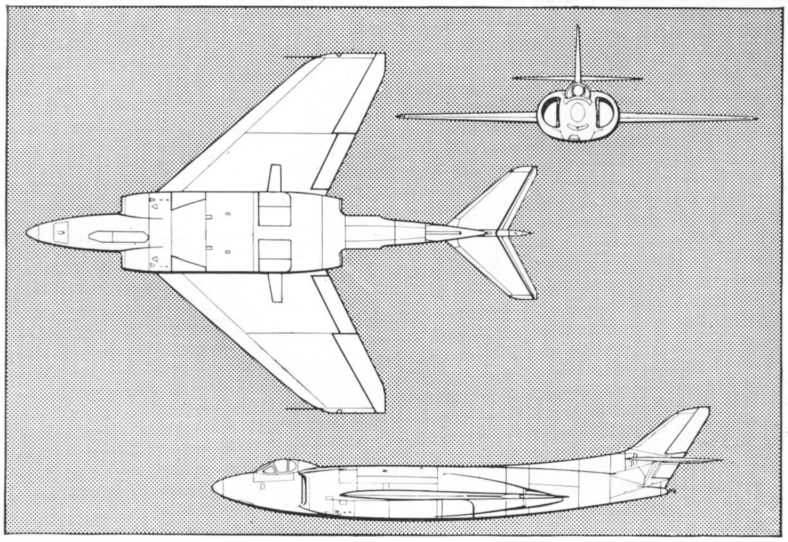
The XFV-1 stands on small wheels at the tips of its cruciform tail assembly for take-off and is lowered onto these when landing. The pilot's seat is mounted on gimbals, tilting forward 45° while the aircraft is in the vertical attitude. The XFV-1 is intended primarily as a development aircraft and maximum level speed does not exceed 500 m.p.h. Approximate dimensions are: span, 24 ft.; length, 28 ft.; height (tail, top to bottom), 11 ft.

The XFV–1 Salmon vertical-take-off fighter is shown (left) *on transporter, and* (right) *on temporary undercarriage.*






Derived from the Types 508 and 529, the Type 525 (VX138) is providing data for a more advanced fighter.

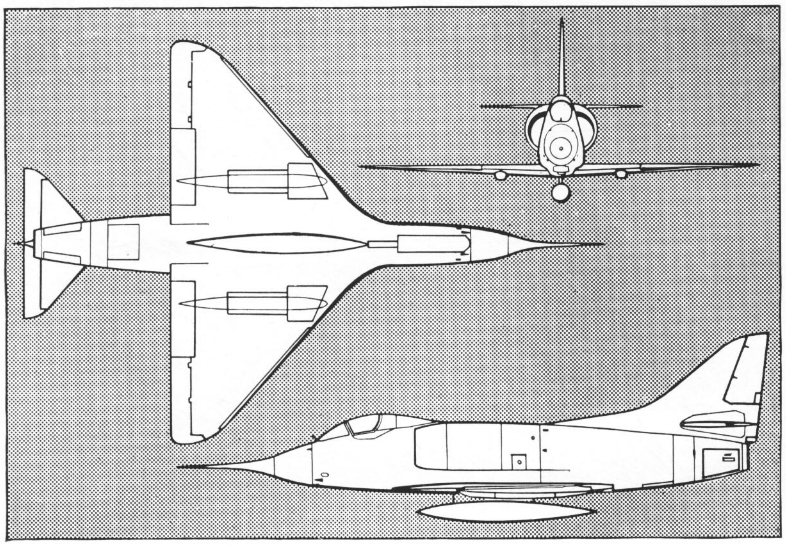


SUPERMARINE TYPE 525 (APRIL) 1954

Derived from the straight-wing Types 508 and 529 and representing the second stage in the development of a new carrier-borne, single-seat interceptor fighter and strike aircraft for the Royal Navy, the Type 525 differs from its predecessors primarily in having swept mainplanes and a more conventional tail with sweepback on horizontal and vertical surfaces.

Flown for the first time on April 27, 1954, the Type 525 is powered by two Rolls-Royce Avon turbojets and is the largest single-seat jet fighter yet produced by the British aircraft industry. The fuselage is similar to those of the Types 508 and 529 with lateral intakes for the Avon turbojets and an overall length of some 55 ft. The broad chord wing has a span of 38 ft. 6 in. and is swept approximately 45° at quarter-chord. Full-span slats and ample flap area keep approach speeds within the limits imposed by carrier operations. A nosewheel undercarriage is fitted, all members retracting into fuselage housings, and to preserve the airflow the mainwheel-well fairing doors close after the wheels are fully extended. Air brakes hinge forward on the fuselage just below the wing leading edge.

It has been revealed that a substantial production order has been placed for a progressive development of the Type 525 which will presumably incorporate wing-folding mechanism and higher-powered turbojets. The Type 525 can attain supersonic speeds in a shallow dive, and it can be presumed that the developed version will exceed Mach 1·0 in level flight. Armament is likely to comprise four 30-mm. Aden guns and, in the close-support role, various underwing loads, including tactical atomic weapons.



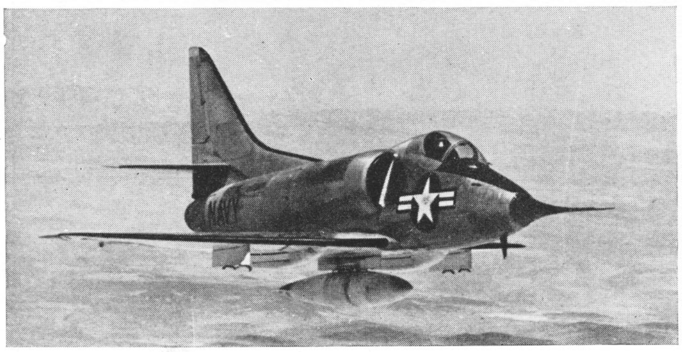
DOUGLAS SKYHAWK (JUNE) 1954

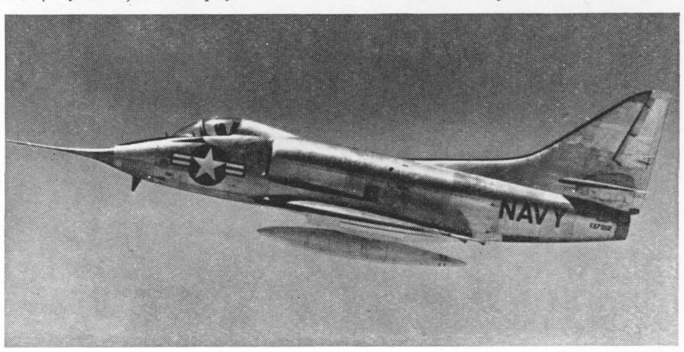
The severe operational problems that have resulted from the increasing complexity and weight of combat aircraft have led to several attempts to reduce these factors by simplifying the airframe and certain equipment without penalising operational capabilities. One such attempt is to be seen in the Douglas A4D–1 Skyhawk carrier-borne attack aircraft.

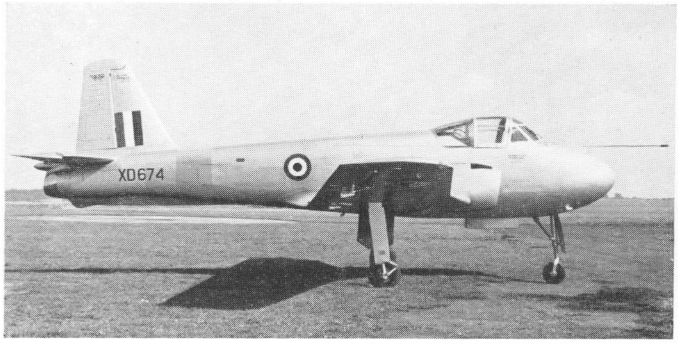
The prototype Skyhawk, the XA4D–1, which flew eighteen months after design work was initiated, on June 22, 1954, is extremely compact. Its delta planform wing has a span of only 27 ft. and thus obviates the need for the usual wing-folding mechanism. Large-chord slats extending over 70 per cent of the wing leading-edge, and split-type trailing-edge flaps are provided to enable the Skyhawk to operate from the smaller U.S. Navy carriers. These low-speed aids render the aircraft unique among current U.S. deltas in necessitating a tailplane. This balances out the trim changes that result from the extension of the slats and flaps, and the unusually large vertical fin compensates for the short tail moment-arm in furnishing adequate damping.

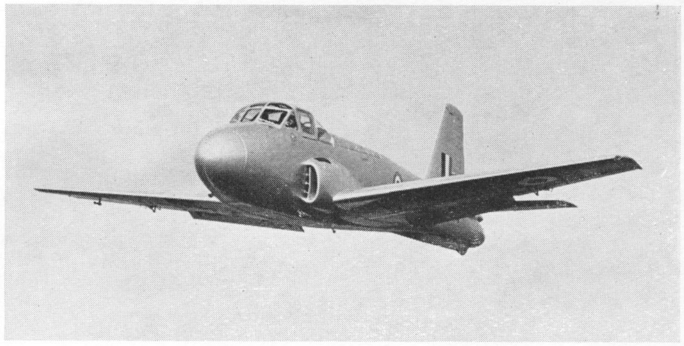
The pilot's cockpit is mounted close up to the nose of the 35-ft. fuselage, and the shoulder-positioned air intakes aft of the cockpit feed air through short intake ducts to the turbojet. The prototype was powered by a Wright J65–W–2 unit of 7,200 lb. thrust but production A4D–1s have the J65–W–4 of 7,800 lb. thrust. Airframe limiting Mach number exceeds unity, but the Skyhawk is designed for level speeds in the subsonic Mach 0·9–0·95 range. As an interceptor, normal loaded weight is 15,000 lb.

The XA4D–1 (illustrated here, and now in production as the A4D–1 Skyhawk) is a simplified carrier-borne attack aircraft.



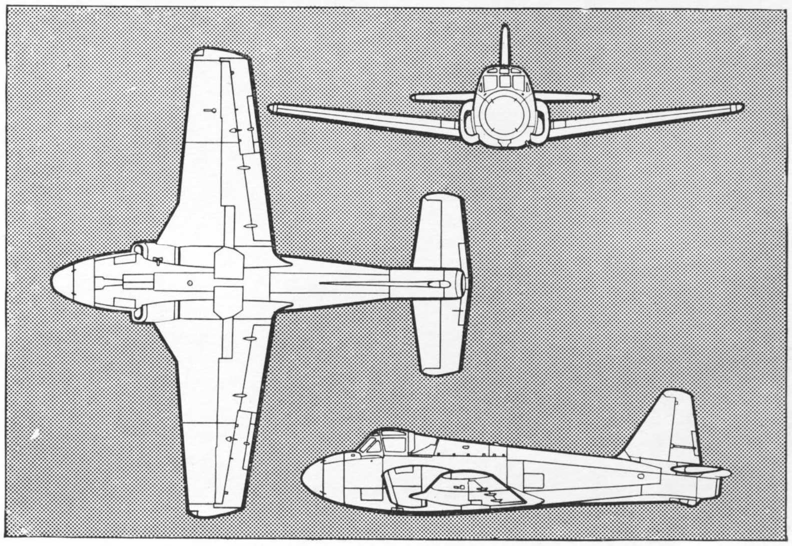






The first prototype Jet Provost (XD674) employs Provost wing and tail assemblies.

HUNTING PERCIVAL P.84 (JUNE) 1954

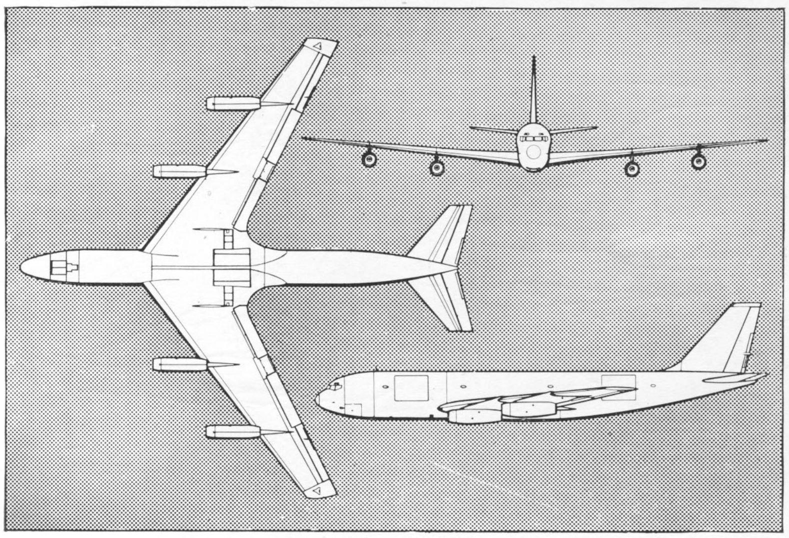


One of the world's first jet-propelled basic trainers, the P.84 Jet Provost consists of standard Provost piston-engined trainer wing and tail assemblies matched with a fuselage housing a 1,640 lb. thrust Armstrong Siddeley Viper A.S.V.5 turbojet. The P.84 was designed as a private venture and a service-trials batch of Jet Provosts was ordered by the R.A.F. in March 1953 in order that a direct comparison can be made with the Provost piston-engined basic trainer.

The Jet Provost, intended to train pilots from the outset of their flying career, flew for the first time on June 26, 1954. The primary aim of the designer has been to obtain the safe-handling characteristics necessary for initial training, with performance as a secondary requirement. The undercarriage is of nosewheel type and of long travel to allow for the tail-down landing attitude, air brakes are fitted on the under surfaces of the mainplanes, and lift spoilers are attached to the upper surfaces. Internal bag-type tanks provide a total fuel capacity of 171 Imp. gal. which is sufficient for an endurance of 1·49 hr. at sea level and 1·82 hr. at 20,000 ft. These can be increased to 2·45 hr. and 3·06 hr. by the attachment of two 50 Imp. gal. drop tanks at the wing-tips. The fuel system permits continuous inverted flight for 60 sec. with power on.

The Jet Provost has a maximum speed of 303 m.p.h. at sea level and 323·5 m.p.h. at 20,000 ft. Maximum range is 493 miles at 158 m.p.h. at 20,000 ft., and ceiling is 31,000 ft. Normal and maximum loaded weights are 5,950 lb. and 6,750 lb. respectively, and overall dimensions are: span, 35 ft. 5 in.; length, 31 ft. 11 in.; height, 12 ft. 8 in.

BOEING MODEL 707 (367–60) (JULY) 1954

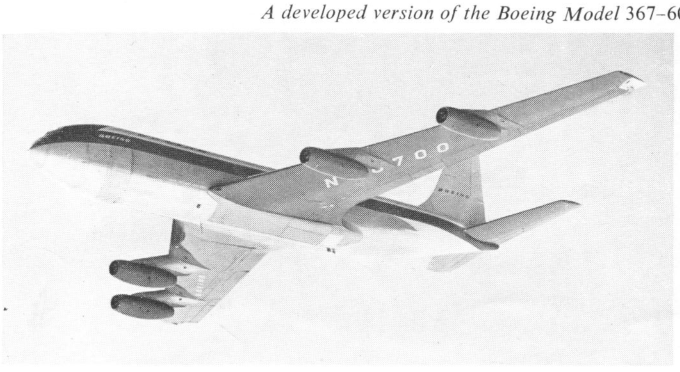


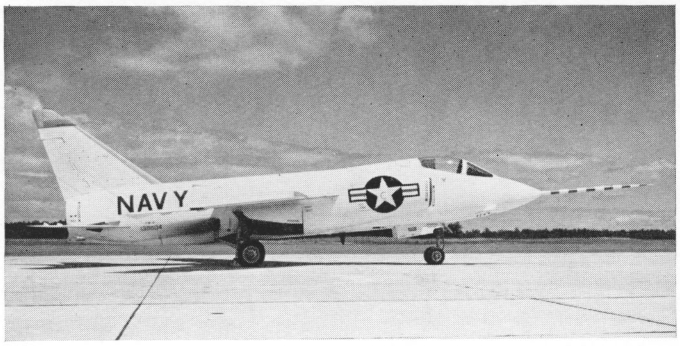
The Boeing Model 367–60, popularly known as the Model 707, the first pure-jet transport of U.S. design, was developed as a private venture with the potential roles of military aerial refuelling tanker and long-range commercial airliner. Featuring a flexible, narrow-chord wing swept at 35° and four Pratt and Whitney J57 turbojets of some 9,500 lb. thrust each, installed in single pods projecting ahead of the wing leading edge, the prototype flew for the first time on July 15, 1954.

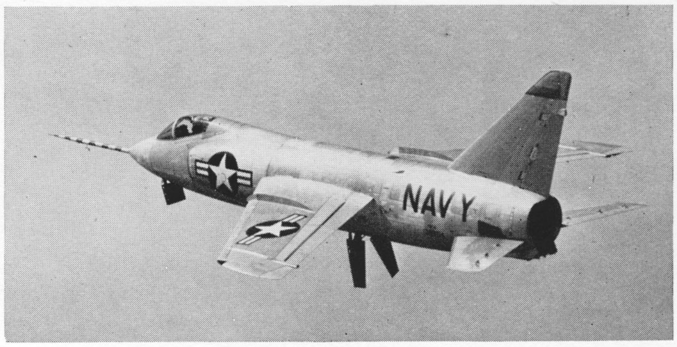
The straight-taper swept wing has divided ailerons, the wide-chord mid-span ailerons safeguarding against the reversal of the normal ailerons near the wing-tips at high speeds. Double-slotted extension flaps are fitted. Wing span and area are 130 ft. and 2,400 sq. ft. respectively. The slab-sided fuselage has a length of 127 ft. 10 in., and height is 38 ft. 3 in. The prototype was built as a tanker aircraft, and on August 5, 1954, the U.S.A.F. placed an order for an enlarged model to be designated KC-135 Stratotanker. The KC-135 will feature a longer fuselage than that employed by the prototype, and maximum loaded weight will be increased to 225,000-250,000 lb. The projected commercial model, known as the Stratoliner, will be powered by four 9,500 lb. thrust Pratt and Whitney JT3-L turbojets (commercial J57s) and will carry 80-130 passengers over a range of 2,300 miles.

During early flight testing the prototype averaged 636 m.p.h. between Seattle and Portland, but normal cruising speed is expected to be 525 m.p.h. at 35,000 ft. The prototype has an empty weight of 88,890 lb. and an approximate loaded weight of 190,000 lb. Total fuel tankage is 14,896 Imp. gal.

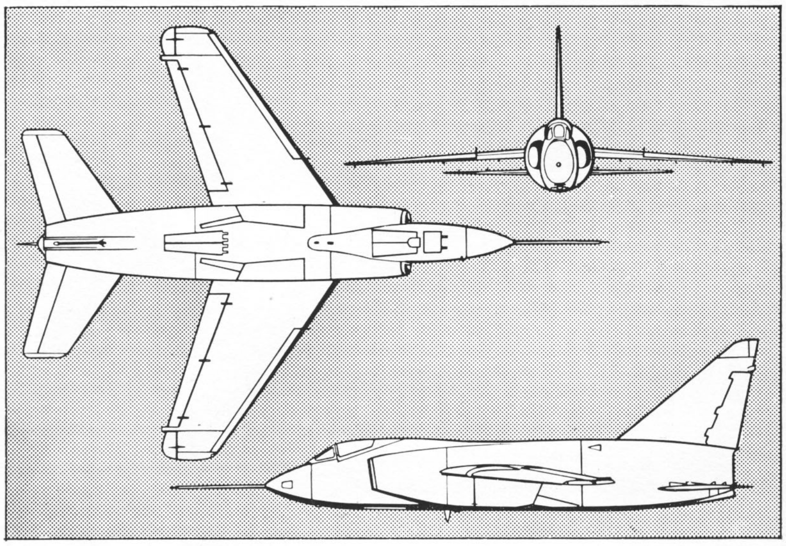
A developed version of the Boeing Model 367–60, the KC–135, has been ordered by the U.S.A.F.







Illustrated here is the first of six pre-production F9F–9 Tiger carrier-borne single-seat fighters.



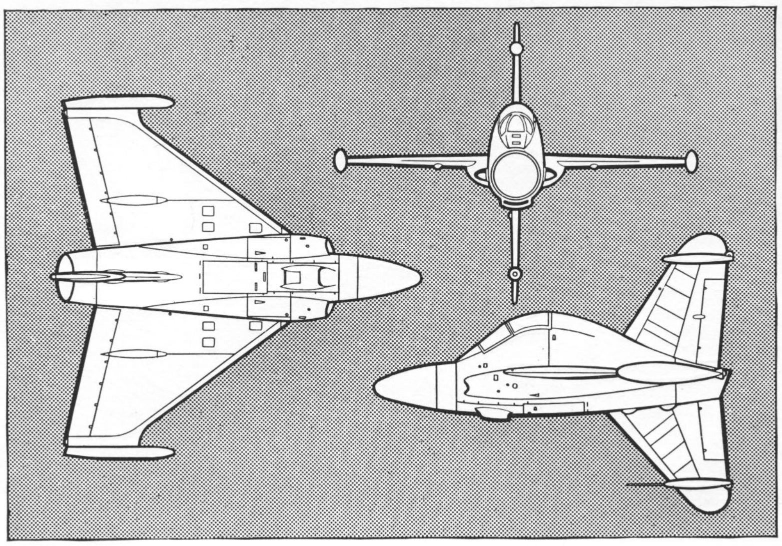
GRUMMAN F9F–9 TIGER (JULY) 1954

The first single-seat carrier-borne fighter capable of attaining supersonic speeds in level flight, the Model 198, or F9F–9 Tiger, flew for the first time on July 30, 1954, only fifteen months after the design had been accepted by the U.S. Navy.

The Tiger is intended primarily for use as an " air superiority " fighter and has been simplified in all possible respects as compared with contemporary shipboard fighters. Particular attention has been paid to weight-saving, with the result that the Tiger weighs only 13,850 lb. in normal loaded condition as compared with some 18,000 lb. for its predecessor, the Cougar. The wing has a thickness/chord ratio of approximately 6·5 per cent and the upper wingskin is machined from a single sheet of aluminium. It is manually folded for carrier stowage in order to avoid complex and weighty folding mechanism, and carries full-span flaps, leading-edge slats and spoiler panels which, combined with small tip ailerons, provide lateral control.

Initial U.S. Navy contracts called for six pre-production and 39 production Tigers, additional contracts being awarded in October 1954. The prototype—actually the first pre-production machine—is powered by a 7,500 lb. thrust Wright J65–W–7, whereas production aircraft will have the J65–W–4 of 7,800 lb. thrust, which can be augmented by afterburning to some 11,000 lb. thrust.

The F9F–9 Tiger has a maximum speed in excess of Mach 1·0 and a service ceiling of some 50,000 ft. Armament comprises four 20-mm. cannon. Overall dimensions are: span, 31 ft. 5 in.; length, 39 ft.; height, 14 ft. 10 in.



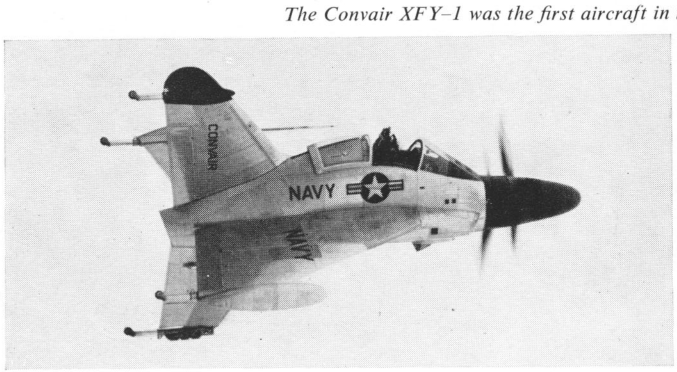
CONVAIR XFY–I (AUGUST) 1954

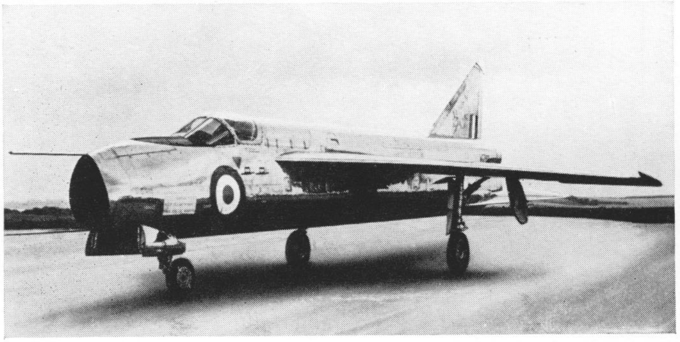
Resulting from the U.S. Navy design competition held in 1950 for a single-seat fighter possessing vertical take-off characteristics, the Convair XFY-1 made the first known successful vertical take-off on August 1, 1954, and its first horizontal flight in November, 1954.

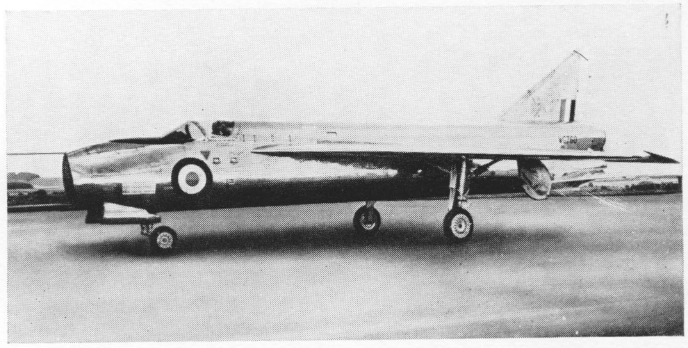
Powered by a 5,850 e.h.p. Allison YT40-A-14 turboprop unit which has been specially developed for vertical take-off operations and provides a maximum power of 7,100 e.h.p. for a short period for take-off, the XFY-1 is likely to be the forerunner of vertical take-off fighters to be based on cargo vessels, troop transports and smaller warships. Employing a wing of delta planform swept at an angle of 52° at the leading edge and spanning 25 ft. 8 in., the XFY-1 possesses extremely large top and bottom tail surfaces which themselves span 22 ft. 7 in. The over-all length of the fuselage is 30 ft. 9 in., and the pilot has a gimbal-mounted seat which tilts forward 45° when the aircraft is in the vertical position and returns to a normal position as soon as horizontal flight is attained. The landing gear comprises four small castoring wheels, two mounted at the wing-tips and two on the vertical tail surfaces, the XFY-1 resting on these for take-off. The support provided by this undercarriage is claimed to be such that the XFY-1 will topple only when an angle of 26° off-centre is exceeded.

The XFY-1 is intended primarily for shipboard use and can hover in a vertical position. The lower tail fin can be jettisoned for an emergency horizontal landing. The T40 engine comprises two separate turbine components and, with reduced load, the XFY-1 can land with one half of the turboprop inoperative. Maximum speed is approximately 500 m.p.h.

The Convair XFY–1 was the first aircraft in the world to effect a successful vertical take-off.







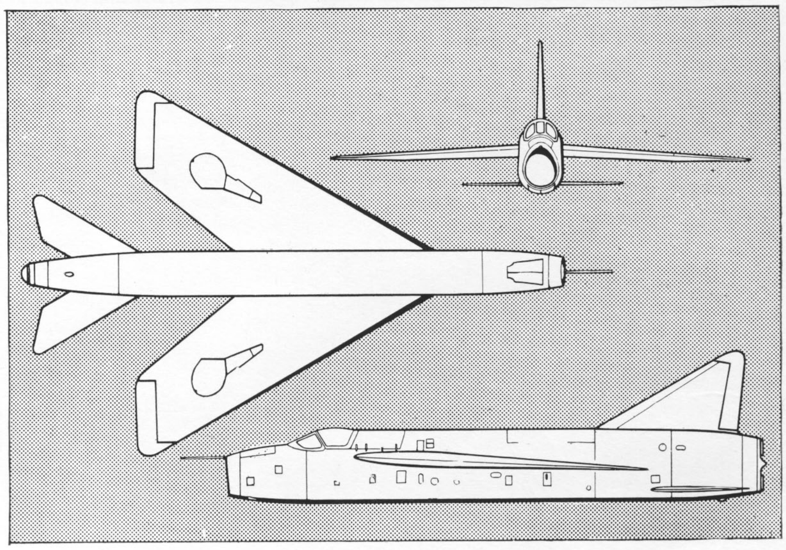
The first prototype English Electric P.1 (WG760) supersonic interceptor fighter.

ENGLISH ELECTRIC P.1 (AUGUST) 1954

The first combat aircraft of British design to achieve supersonic speeds in level flight, the English Electric P.1 flew for the first time on August 4, 1954, and had, within two weeks of its first flight, exceeded Mach unity in level flight on several occasions.

Many of the design features of the P.1 fighter were first tested on the Short S.B.5 low-speed flying scale-model which was built after the basic design of the P.1 had been finalised. The mid-positioned wing is swept at an angle of some 60°, and of especial interest is the arrangement of the ailerons across the wingtips. In this respect they are analogous to those of a delta. The fuselage possesses considerable depth, and the two Armstrong Siddeley Sapphire turbojets (possibly 10,200 lb. thrust A.S.Sa.7 type), superimposed one above the other in the rear fuselage, are fed via a pitot-type air intake and exhaust through superimposed tailpipes. This arrangement offers the obvious advantage of enabling the P.1 to cruise economically on the power of one turbojet without any asymmetric problems. The tailplane is attached at the base of the rear fuselage clear of the turbulent airflow from the wing, and, despite its extremely thin section, the wing houses the main members of the nosewheel undercarriage.

In addition to the usual prototypes, twenty pre-production P.1 fighters were ordered from the drawing-board for development trials. No details of the P.1 have been revealed apart from what can be seen from available photographs, but it can be assumed that the P.1 will attain level speeds in the Mach 1·3-1·5 range.

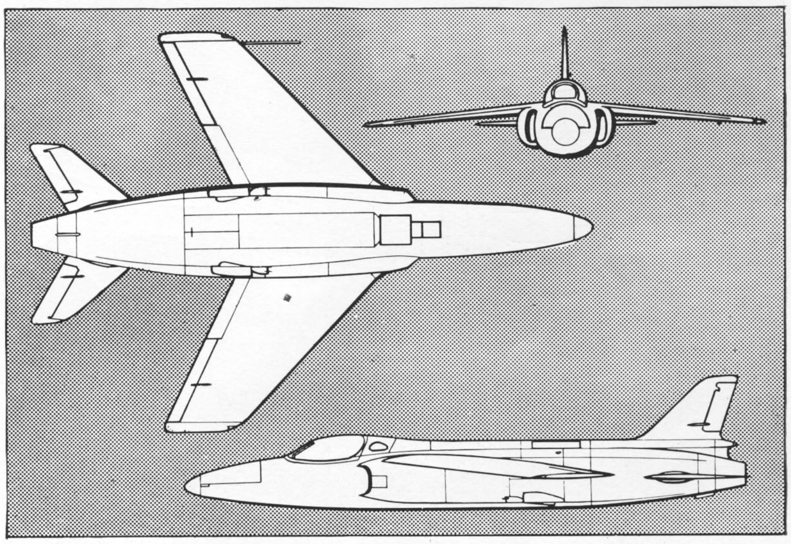


FOLLAND FO 139 MIDGE (AUGUST) 1954

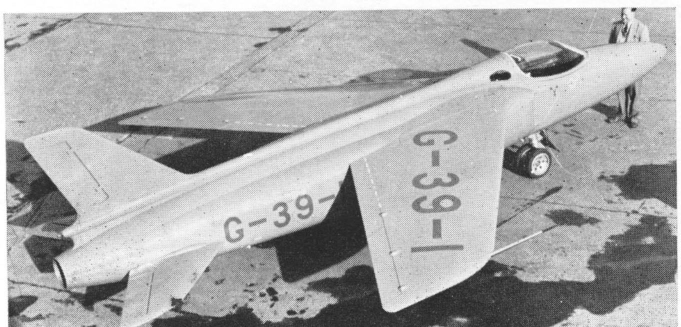
Motivated by the conviction that a small, simplified high-performance aircraft can perform most of the operations required of today's large and complicated single-seat fighters, in 1951, W. E. W. Petter commenced design of a lightweight fighter which, in comparison with an orthodox fighter, would require only one-fifth of the production man-hours and cost less than one-third without compromising performance.

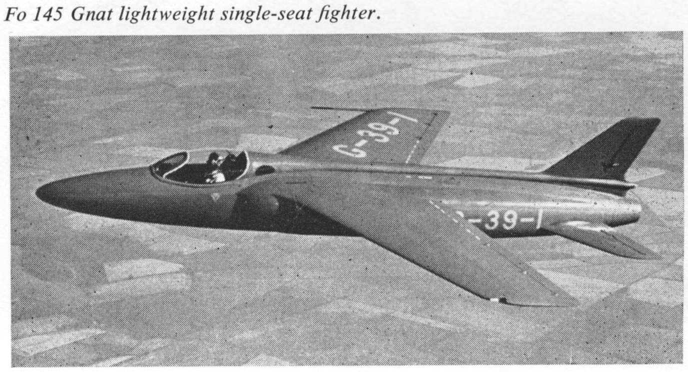
The original design study evisaged the use of the 3,800 lb. thrust Bristol Saturn turbojet and was designated Fo 141 Gnat Mk.1. However, discontinuation of Saturn development resulted in its replacement by the 4,850 lb. thrust Bristol B.E.26 Orpheus which, with afterburning, will give 6,000 lb. thrust. With this turbojet the fighter will be known as the Fo 145 Gnat Mk.2 To prove the airframe, aerodynamics and power systems of the Gnat, a low-powered prototype, the Fo 139 Midge, has been built. Virtually identical to the Gnat, the Midge is powered by a 1,640 lb. thrust Armstrong Siddeley Viper 101 (A.S.V.5) turbojet and flew on August 11, 1954.

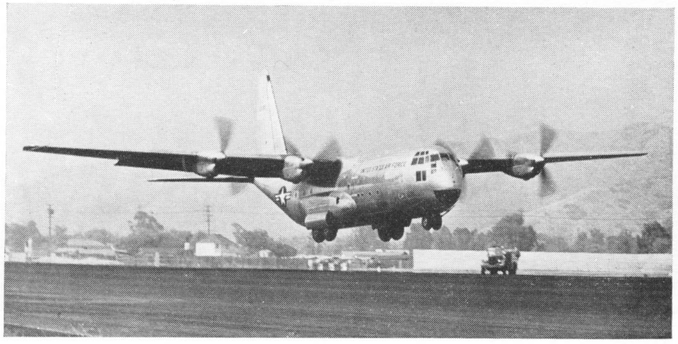
Whereas the Midge weighs only 4,500 lb. loaded and has a maximum speed of 604 m.p.h., the later Gnat will weigh some 6,000 lb. and has an estimated maximum speed of 725 m.p.h. The airframe limiting Mach number will be approximately 1·02. The Gnat will carry a built-in armament of two 30-mm. cannon, and the requisite strength margin has been allowed to enable it to fulfil the ground-support role with underwing loads of twelve 3-in. rockets or two 500-lb. bombs. Initial climb rate and endurance will be 8,000 ft./min. and 3 hrs. respectively. Dimensions are: span, 20 ft. 8 in.; length, 28 ft. 9 in.; height, 9 ft. 3 in.

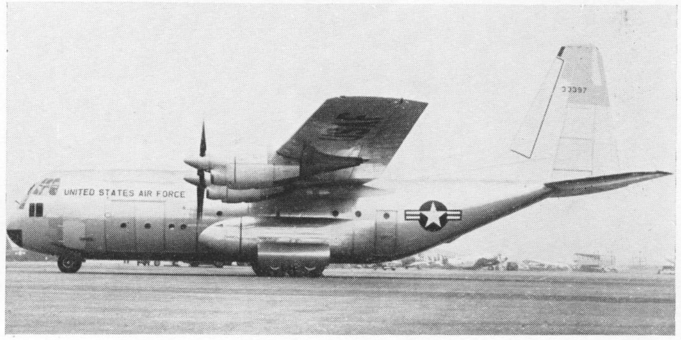


The Midge is a low-powered prototype for the Fo 145 Gnat lightweight single-seat fighter.

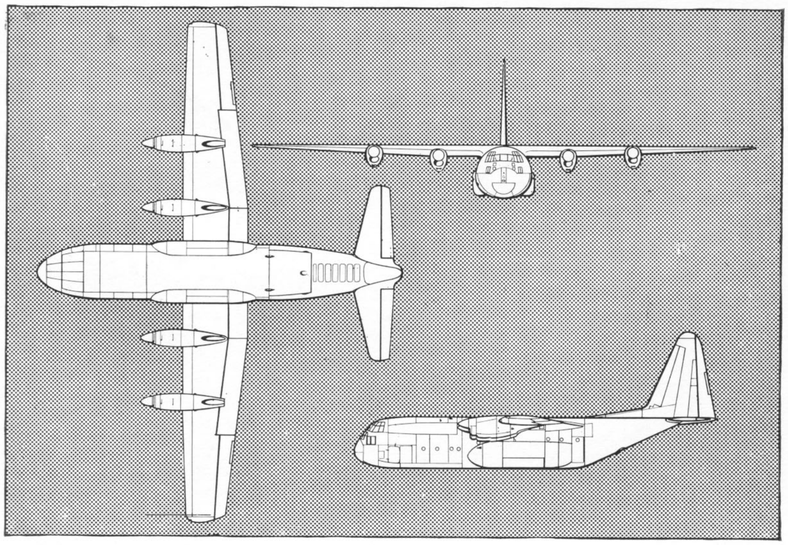








The first of two YC–130 prototypes for the C–130A Hercules military transport.

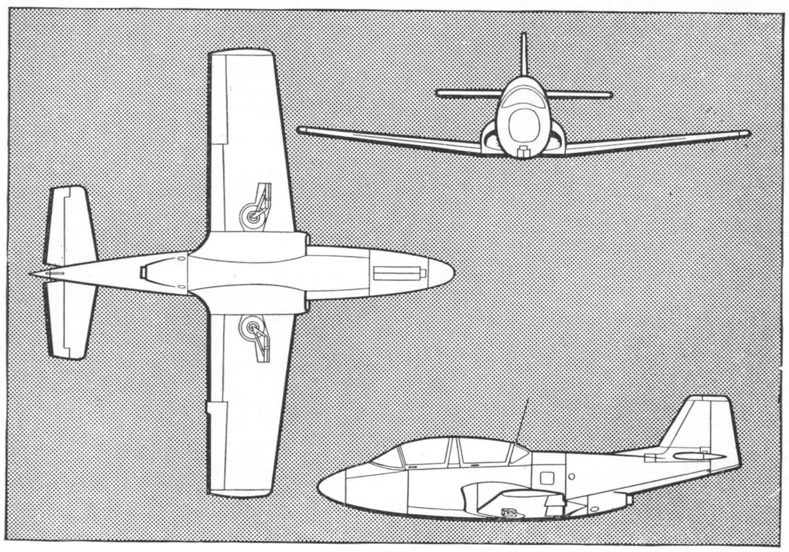


LOCKHEED HERCULES (AUGUST) 1954

The first American transport aircraft to be intended for turbo-prop power from the outset of design, the Lockheed Model 82, or YC-130, is the outcome of a joint specification compiled by the U.S.A.F. in co-operation with the U.S. Army and the Military Air Transport Service. The specification called for an aircraft capable of operating as a low-altitude, moderate-speed, short-range transport for assault missions and parachute drops, operating from short, unprepared landing areas, as well as the long-range hauling of military loads at high altitude and high speed.

The transport is characterized by a high-mounted, high aspect ratio wing, a low-slung, circular-section fuselage with uplifted tail unit and a narrow-track undercarriage, the four tandem-mounted mainwheels of which retract into large blisters standing proud of the fuselage sides. The rear fuselage includes a loading ramp which facilitates the rapid handling of bulky cargoes. As an in-flight refuelling tanker, six 333 Imp. gall. tanks will be carried and probe-drogue type refuelling gear.

The first of two YC-130 prototypes was flown on August 23, 1954, powered by four 3,750 s.h.p. Allison YT56-A-1 turbo-props and, as the Model 182 C-130A Hercules, quantity production is being undertaken for the U.S.A.F. The C-130A Hercules will have approximate maximum and cruising speeds of 405 m.p.h. and 380 m.p.h. at 30,000 ft., and maximum range is 2,500-3,000 mls. Empty weight is 57,500 lb., and normal loaded weight, 108,000 lb. and 124,200 lb. maximum. Overall dimensons are: span, 132 ft., length, 94 ft. 9½ in.; height, 38 ft., 3½ in., wing area, 1,745 sq. ft.



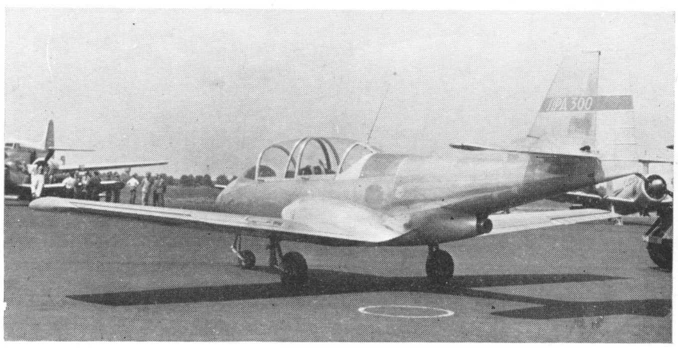
S.I.P.A.300 (SEPTEMBER) 1954

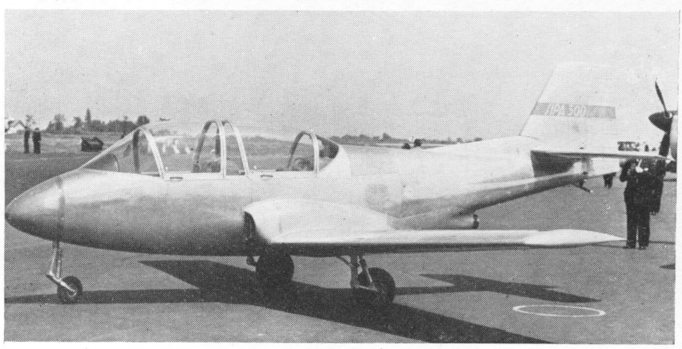
The S.I.P.A.300 tandem two-seat elementary trainer has been developed by the Société Industrielle pour l'Aeronautique as a potential replacement for currently used piston-engined elementary trainers, and design emphasis has been upon structural simplicity and ease of maintenance. Utilising the outer wing panels of the earlier S.I.P.A.200 Minijet, the S.I.P.A.300 is currently powered by a 350 lb. thrust Turboméca Palas turbojet, but provision has been made for the alternative installation of higher-powered turbojets, such as the 480 lb. thrust Super Palas, the Turboméca Aspin II or the Marboré II.

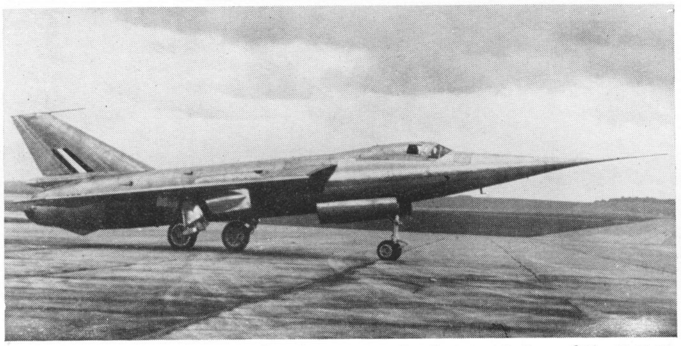
The S.I.P.A.300 flew for the first time on September 4, 1954. The Palas turbojet is installed in the lower fuselage above the wing trailing edge, is fed by small wing-root intakes and exhausts below the upswept rear fuselage assembly. The S.I.P.A.300 is claimed by its manufacturers to be of exceptionally low cost and the world's first jet trainer designed from the outset for *ab initio* instruction. A projected alternative role for the S.I.P.A.300 is that of military liaison.

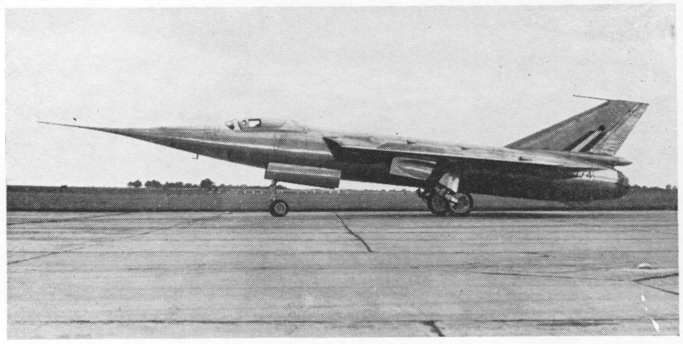
The estimated performance of the S.I.P.A.300 is as follows: maximum speed, 224 m.p.h.; cruising speed, 205 m.p.h.; range, 435 miles, initial climb rate, 894 ft./min., ceiling, 16,500 ft. Empty and loaded weights are 1,115 lb. and 1,874 lb. respectively, and overall dimensions are: span, 26 ft. 3 in.; length, 22 ft.; height, 5 ft. 10½ in.; wing area, 104·4 sq. ft. With the Super Palas turbojet the S.I.P.A.300 may be utilised for both primary and basic training, and it is claimed that the pupil pilot will be able to graduate directly to an advanced trainer, eliminating the intermediate stage.

The S.I.P.A.300 is one of the very few jet aircraft suitable for use as an elementary trainer.









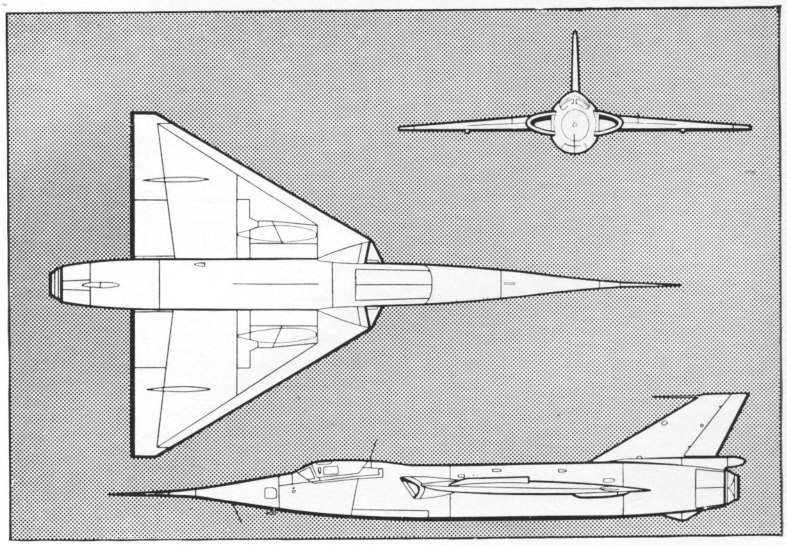
The planview in the drawing below of the F.D.2 research aircraft should be considered as provisional.

FAIREY F.D.2 (OCTOBER) 1954

Although designed initially to investigate flight problems at high subsonic speeds, during the course of design and development of the F.D.2 research aircraft it became apparent that considerably higher speeds would be attainable, and the F.D.2 is now engaged upon a programme of trans-sonic and supersonic flight research.

Of extremely advanced aerodynamic design, the F.D.2 flew for the first time on October 6, 1954. A small wing of delta planform with a thickness/chord ratio of between 4 per cent and 5 per cent is employed and, despite its exceptionally thin section, the main undercarriage members are housed almost entirely in the wing. The fuselage of the F.D.2 incorporates the novel feature of a hinge which allows the nose to "droop" to improve the pilot's view for landing—forward view might otherwise be restricted owing to the exceptional length of the nose and the high angle of incidence of the landing approach which is a common characteristic of delta aircraft.

Aft of the forward-positioned pilot's cockpit the fuselage is of almost constant section, housing a Rolls-Royce Avon turbojet of some 10,000 lb. thrust fed via bulged scoops at the wing roots. The rear fuselage contours suggest that the thrust of the Avon can be augmented by an afterburner. The design of the F.D.2 was supported by an extensive programme of wind-tunnel tests with models, and it can be expected that the research aircraft will attain speeds in level flight considerably in excess of Mach 1.0. No details concerning dimensions and weights are available for publication at the time of closing for press.

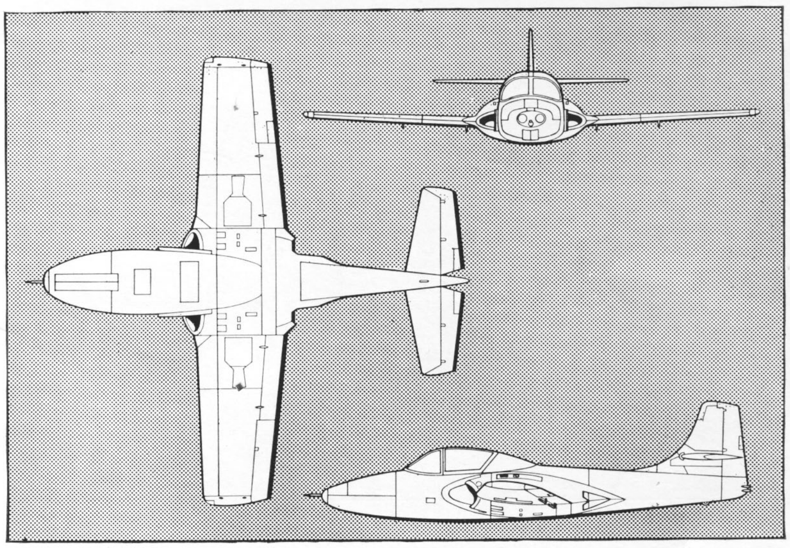


CESSNA XT-37 (OCTOBER) 1954

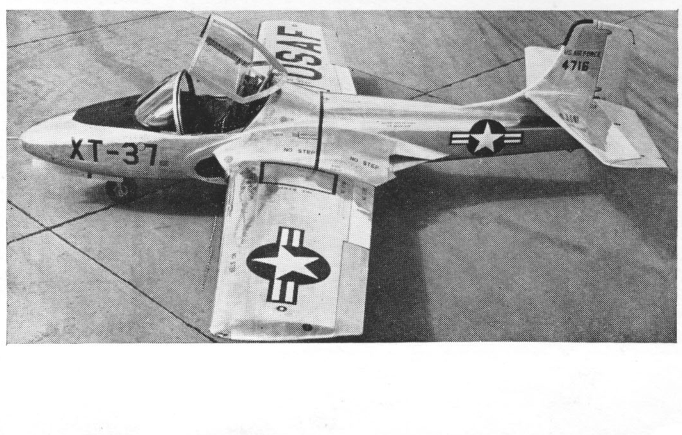
The Cessna Model 318, or XT-37, has been designed to meet U.S.A.F. requirements formulated in 1952 for a jet basic trainer for use as an intermediate stage between primary training on a piston-engined type and advanced training on a high-speed jet aircraft. Flown for the first time on October 12, 1954, the XT-37 is powered by two 920 lb. thrust Continental J69-T-15 (licence-built developments of the Turboméca Marboré) turbojets faired into the wing roots.

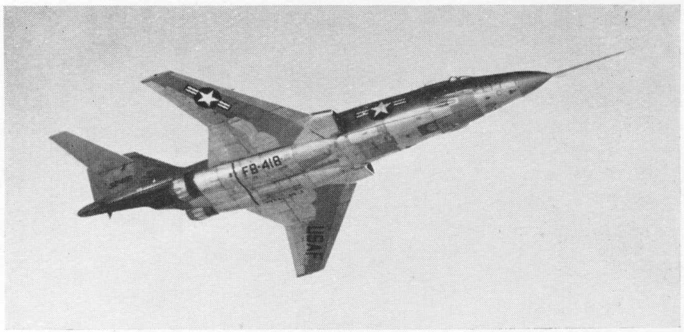
The XT-37 is unusual among U.S. training aircraft in providing side-by-side seating for the instructor and pupil. Construction is all-metal, and the wing incorporates high-lift slotted flaps, and an air brake is located beneath the forward fuselage, lying flush when retracted. The air brake provides speed and dive angle control throughout the trainer's speed range. Equipment includes provision for day and night instrument flying, jettisonable canopy and ejector seats. An interesting feature of the design is the adoption of engine inlet screens which extend automatically over the wing-root intakes when the undercarriage is locked in the down position and retract with the undercarriage. These prevent stones or other debris entering the intake ducts during take-off or landing.

The maximum speed of the XT-37 at 35,000 ft. (with fuel tanks half full) is 393 m.p.h., and maximum range (with 30-min. fuel reserve and cruising at 310 m.p.h.) is 935 miles. Initial climb rate is 3,000 ft./min. Empty and loaded weights are 3,116 lb. and 5,600 lb. respectively, and dimensions are: span, 33 ft.; length, 27 ft. 1 in.; height, 8 ft. 9½ in.; wing area, 181·8 sq. ft.

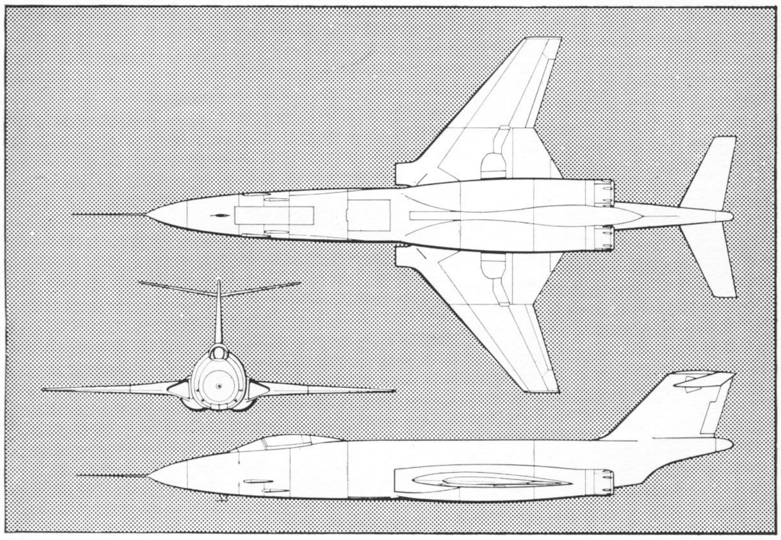


The XT–37 (54–716) is the first jet basic trainer to be designed and built in the U.S.A.





The F–101 Voodoo is an enlarged and more powerful development of the XF–88 of 1948.



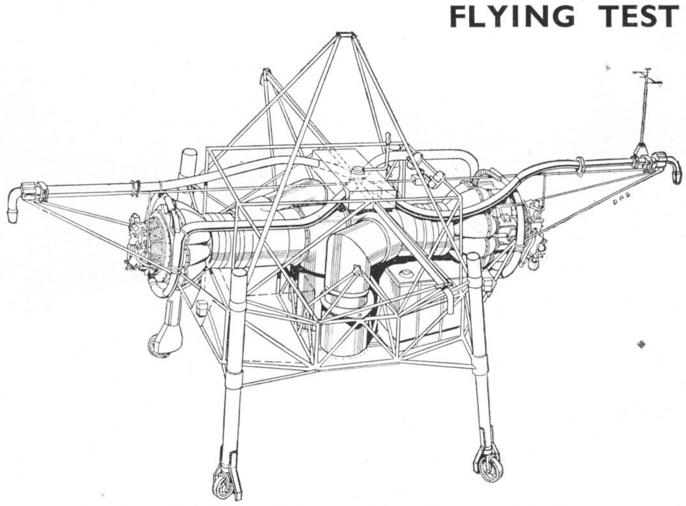
MCDONNELL F-101A (OCTOBER) 1954

The F-101A Voodoo long-range escort fighter is probably the heaviest and certainly the most powerful single-seat combat aircraft extant. First flown in October 1954, the F-101A's design is based upon that of the experimental XF-88 of 1948 (see page 89). Powered by two 9,500 lb. thrust Pratt and Whitney J57-P-13 turbojets with short afterburners housed semi-externally in the fuselage belly, the F-101A grosses more than 40,000 pounds yet its wing area is comparable to that of the Gloster Meteor F.8 which has an all-up weight of less than *half* that of the Voodoo.

Apart from the larger turbojets, the F-101 differs from the XF-88 in having a lengthened fuselage accommodating additional fuel tanks which increase internal fuel capacity to more than 2,100 Imp. gal. and overall length to 67 ft. $4\frac{3}{4}$ in. The wing span is the same as that of the XF-88 at 39 ft. 8 in., and wing planform was originally identical to that of the earlier machine, but during a late development stage, the area was increased by the rearward extension of the inboard sections which result in a unique planform and carry large-area, irregular-shaped braking surfaces. The vertical tail surfaces are of extremely low aspect ratio and carry a high-mounted slab-type tailplane with marked dihedral and a wide arc of movement. Built-in armament comprises four or six 20-mm. M-39 cannon. Despite the considerable physical depth of the inboard wing sections, the thickness/chord ratio is only some 6%, reducing to 4%-$4\frac{1}{2}$% at the tip.

With recourse to afterburning, maximum speed at 36,000 ft. is of the order of 980 m.p.h. and initial climb rate is 16,000 ft./min. The RF-101A is a photo-reconnaissance variant.

FLYING TEST BEDS



Over the past two decades it has become customary practice to adapt existing airframes for the air testing of new aero engines. This practice has resulted in a wide variety of interesting hybrid aircraft known as flying test beds, the vast majority of which are illustrated on pages 11 to 31 and are listed below and on the following page. Also included in the table are the various jet conversions of piston-engined aircraft made for airframe rather than engine development purposes.

The largest number of flight test beds are concerned with the proving of new engines, but others are developed to provide data on various operational aspects of jet engines. The most interesting test bed in the latter category is the experimental rig (illustrated on the left) built by Rolls-Royce for vertical take-off trials. Powered by two 5,000 lb. thrust Nene turbojets, the thrust 7 lines of which are diverted downwards, the rig is primarily a framework supporting the fuel tanks, pilot's seat and instruments. While vertical motion up or down can be controlled by increasing or decreasing the turbo-jet thrust, horizontal motion is achieved by tilting the whole machine by means of auxiliary exhaust pipes which extend fore and aft and at each side of the rig. Air is fed to the downward-pointing ducts at rates which can be varied by the pilot, small variations in thrust tipping the rig in any chosen direction.

The Rolls-Royce test rig is concerned primarily with the matter of control and stability in vertical take-off aircraft.

Engine	*Aircraft*	*Marking*	*Flight Date*	*Notes*
CANADA				
Orenda	Lancaster	FM209	13/7/50	Two engines, outboard nacelles.
FRANCE				
Aspin I	Gemeaux IV	F–WEPJ	6/11/51	One, above centre section.
Aspin II	Gemeaux V	—	21/6/52	One, above centre section.
Atar 101	Marauder	43–34584	Mid '51	In rear fuselage.
Atar 101	Languedoc	E	22/10/51	Above fuselage. Atar 101F with afterburner later.
Atar 101B2	Ouragan	MD450–14	5/12/51	Last two pre-production Ouragans.
Atar 101	Meteor IV	RA491	31/10/52	Originally with two Avon.
Atar 101	SO 30P	F–WAYD	27/1/53	Two in place of piston engines.
Atar 101F	Mystere IIC	MD452–019	21/2/54	First afterburning Atar. Two Mysteres fitted.
Escopette	Emouchet	No. 203	30/11/50	Four S.N.E.C.M.A. 3340 under wings.
Escopette	Emouchet	F–WGGH	6/51	Six S.N.E.C.M.A. 3340 under wings.
Escopette	Emouchet	F–WGGG	—	Four S.N.E.C.M.A. 3340 under wings.
FRANCE (contd.)				
Marboré I	Gemeaux II	—	16/6/51	One, above centre section.
Marboré II	Gemeaux III	—	24/8/51	One, above centre section.
Marboré	Espadon	--	—	Two, at wing tips, with afterburners.
Nene	SO 30R	F–WAYB	15/3/51	Two in place of piston engines.
Nene 104R	Ouragan	MD450–3	End '53	First French afterburner flight.
Pimene	Gemeaux I	F–WEPJ	6/3/51	Two, one above each fuselage.
S.E.P.R. 251	Espadon SO 6025	—	28/12/49	S.O. 6020–03. Fuel in fuselage.
S.E.P.R. 251	Espadon SO 6026	—	15/10/51	S.O. 6020–02. Fuel in wing-tip tanks.
S.F.E.C.M.A.S. 600	Ju 88G	—	—	Two under wing.
S.F.E.C.M.A.S. 600	Meteor 11	NF–11–3	End '53	Two under wing.
Tay 250	Ouragan	—	—	Hispane-built Tay
TG 1008	Languedoc	—	—	Above fuselage.
Verdon	Mystere IVa	—	3/8/53	—
Vulcain	Armagnac	—	—	Not yet flown.

Engine	Aircraft	Marking	Flight Date	Notes
GERMANY				
Argus 109-014	Gotha Go 145	—	28/4/41	Under fuselage.
B.M.W. 109-003	Me 110	—	1941	Under fuselage.
B.M.W. 109-003A-0	Ju 88	—	10/43	Under fuselage.
Heinkel-Hirth 109-001	Ju 88	—	1944	Under fuselage.
Junkers 109-004A	Me 110	—	15/3/42	Under fuselage.
Pabst ramjet	Do 17Z	—		Above fuselage.
Sanger ramjet	Do 217E	—		Above fuselage.
Kummensdorf Rocket	He 112	—	1937	In rear fuselage. 650 lb. thrust.
Peenemunde Rocket	He 112	—	1939	In rear fuselage. 2,000 lb. thrust.
GREAT BRITAIN				
Adder	Lancaster	SW342	—	In rear fuselage.
A.S.X.	Lancaster 6 U.T.B.	ND784/G	6/45	In bomb-bay. A.S.X.5 and A.S.X.7 flown.
Avon	Lancastrian	VM732	8/48	Two Avon outboard.
Avon	Lancastrian	VL970	—	Two Avon outboard.
Avon	Meteor 4	RA491	—	Two Avon only.
Avon	Canberra 2	WD943	—	First Avons with re-heat.
Clyde	Wyvern	VP120	18/1/49	Only Clyde flights.
Dart	Lancaster	NG465	11/47	Dart in nose.
Dart	Dakota	KJ829	—	Two Dart only.
Dart	Dakota	G-ALXN	Mid '51	B.E.A. turboprop experience.
Dart	Dakota	G-AMDB	Mid '51	B.E.A. turboprop experience.
Dart	Wellington	LN715	—	Two Dart only. Vickers turboprop experience.
Derwent	Wellington	—	12/43	Derwent in rear fuselage.
Derwent	Meteor 4	RA435	—	Two Derwent with afterburners.
Derwent	Meteor 4	VT196	—	Two Derwent with afterburners.
Derwent	Lincoln	SX971	—	One Derwent with afterburner in bomb-bay.
Eland	Varsity	VX835	Mid '54	First flights with one Eland, now with two.
Eland	Convair 340	—	1955	Installation in U.K.
Eland	Ambassador	G-ALFR	1955	Two Eland only.
F.2	Lancaster	BT308	29/6/43	Third F.2 in rear fuselage.
F.2	F.9/40	DG204	13/11/43	First British all-axial flight.
F.2	Lancaster B.2	LL735	1944	Replaced BT308.
F.2/4 Beryl	Meteor 4	RA490	—	—
Goblin H.1	F.9/40	DG206	5/3/43	First F.9/40 flight.
Goblin	Vampire	VV454	—	Afterburning Goblin.
Ghost	Lancastrian	VM703	—	Two Ghost outboard.
Ghost	Lancastrian	VM729	—	Two Ghost outboard.
Ghost	Vampire	TG278	8/5/47	Altitude record.
Ghost	Venom	VV612	—	Afterburning Ghost.
Gyron	Short S.A.4	VX158	—	—
Mamba	Lancaster 6	ND784/G	14/10/47	Mamba in nose.
Mamba	Lancaster	SW342	—	Mamba in nose. Adder/Viper in tail.
Mamba	Dakota	KJ389	3/9/49	Flown with A.S.Ma.6 in 1954.
Mamba	Marathon	G-AHXU	21/7/49	Turboprop experience.
Naiad	Lincoln	RF402	—	Naiad in nose.
Naiad	Lincoln	RF530	—	Naiad in nose.
Nene	Lockheed P-80	44-83027	7/45	First Nene flight.
Nene	Vampire	TG276	—	—
Nene	Vampire	TG279	—	—
Nene	Vampire	TG280	—	—
Nene	Vampire	TX807	—	—
Nene	Lancastrian	VH742	14/8/46	Two Nene outboard.
Nene	Lancastrian	VH737	—	Two Nene outboard.
Nene	Tudor 8	VX195	6/9/48	Four Nene.
Nene	Viking	VX856	6/4/48	Turbojet airliner experience.
Phoebus	Lincoln	RA643	—	One Phoebus in bomb-bay.
Proteus	Lincoln	SX972	—	Two Proteus outboard.
Proteus	Ambassador	G-AKRD	Early '54	Two Proteus only.
Python	Lancaster	TW911	3/1/49	Two Python outboard.
Python	Lincoln	RF403	—	Two Python; for high altitude bomb trials.
Olympus	Canberra	WD952	5/8/52	Altitude record.
Olympus	Ashton	—	1955	Two in wing pods with afterburning.
Sapphire A.S.Sa.1	Lancastrian	VM733	19/1/50	Two Sapphire outboard.
Sapphire A.S.Sa.2	Meteor 8	WA820	14/8/50	Time-to-height record.
Sapphire A.S.Sa.2	Hastings	TE583	13/11/50	Two Sapphire outboard. H.P. jet experience.
Sapphire A.S.Sa.6	Canberra	WD933	—	With A.S.Sa.7 in August 1954.
Sapphire	Canberra	WV787	—	With afterburning.
Snarler	Hawker P.1072	VP401	20/11/50	P.1040 with Snarler in fuselage.
Soar	Meteor 8	WA982	Mid '54	One at each wing tip.
Sprite	Comet	G-ALVG	4/51	—
Tay R.Ta.1	Viscount	VX217	15/3/50	Two Tay. Only British Tay flight.
Theseus	Lincoln	RA716/G	17/2/47	Two Theseus outboard.
Theseus	Lincoln	RE339	—	Turboprop experience with Transport Command.
Theseus	Lincoln	RE418	—	Turboprop experience with Transport Command.
Theseus	Hermes 5	G-ALEU	23/8/49	Turboprop experience.
Theseus	Hermes 5	G-ALEV	27/8/50	Turboprop experience.
Trent	Meteor	EE227	20/9/45	First turboprop flight in world.
Viper	Lancaster	SW342	11/52	In tail. First with A.S.V.3; A.S.V.5 in 1954.
Viper A.S.V.7	Canberra	—	—	Viper at one wing tip. With afterburner later.
W.2B	Wellington	—	8/42	Power Jets engine, in tail.
GREAT BRITAIN (contd.)				
W.2B/23	Wellington	—	11/42	Rover engine, in tail.
W.2B	E.28/39	W4046	1/3/43	Rover engine.
W.2B/23	E.28/39	W4046	16/4/43	Rolls-Royce engine.
W.2B	F.9/40 Meteor	DG205	12/6/43	Rover engine for first flight only.
W.2B/23	F.9/40 Meteor	DG205	6/43	Rolls-Royce engine. Also in DG202 and DG208.
W.2B/37	F.9/40 Meteor	DG209	6/44	Rolls-Royce Derwent prototypes.
W.2/500	E.28/39	W4041	23/5/43	Power Jets engine.
W.2/700	F.9/40	DG203	4/44	Power Jets engine.
W.2/700	Meteor	EE249	—	Power Jets engine.
Welland	Wellington	—	—	Rolls-Royce engine in tail.
Welland	Meteor 1	EE215	—	With afterburners.
JAPAN				
Ne 00	Helen	—	1945	One under fuselage.
SWEDEN				
Dovern	Lancaster	80001	—	In nacelle under fuselage.
U.S.A.				
I-14, G.E.C.	XP-59, Bell	—	1/10/42	
I-40, G.E.C.	XP-80A, Lockheed	—	10/6/44	
J30, Westinghouse	FG-1, Corsair	—	21/1/44	J30 under fuselage.
J30, Westinghouse	JM-1, Martin	—	1944-5	J30 in rear fuselage.
J31, G.E.C.	XA-26F, Douglas	44-34586	—	J31 in rear fuselage.
J33, G.E.C.	B-24, Convair	—	—	Two Liberators used.
J34, Westinghouse	XTB3F-1, Grumman	—	10/46	J34 replaced original J30 in rear fuselage.
J34, Westinghouse	XFR-4, Ryan	—	11/46	—
J35, G.E.C.	XB-29G, Boeing	44-84043	—	J35 under fuselage.
J36, Allis Chalmers	XF15C-1, Curtiss	—	7/45	Licence-built Goblin, in rear fuselage.
J36, Allis Chalmers	XTB3F-1, Grumman	—	—	In rear fuselage in place of J30.
J40, Westinghouse	B-45C, North American	—	—	In nacelle under fuselage.
J42, P. & W.	B-29, Boeing	—	1948-9	In pod under fuselage.
J44, Fairchild	Boxcar, Fairchild	N53228	1954	J44 above fuselage.
J47, G.E.C.	XB-29G, Boeing	44-84043	—	In pod under fuselage.
J47, G.E.C.	YB-43, Douglas	44-61509	1948	One J47 with one J35 in fuselage.
J47, G.E.C.	XC-123A, Chase	47-787	21/4/51	Four J47. Experimental transport.
J47, G.E.C.	B-45C, North American	—	—	In pod under fuselage.
J48, P.& W.	B-29, Boeing	—	—	In bomb-bay, with afterburner.
J57, P. & W.	B-50, Boeing	46-036	3/51	In pod under fuselage.
J57, P. & W.	B-45C, North American	—	—	In pod under fuselage.
J57, P. & W.	B-47B, Boeing	49-2643	1954	Two J57, in outboard pods.
J65, Wright	B-17G, Boeing	—	—	In nacelle under nose.
J65, Wright	B-50, Boeing	—	—	In pod under fuselage.
J71, Allison	B-45C, North American	48-008	12/52	Retractable bomb-bay installation. 48-009 also.
J71, Allison	YF-89E, Northrop	—	—	Two YF-89E, with two J71 each.
J73, G.E.C.	XB-29G, Boeing	44-84043	1952-3	In pod under fuselage.
J73, G.E.C.	B-45C, North American	—	—	In pod under fuselage.
T31, G.E.C.	YP-81A, Convair	—	26/12/45	—
T34, P. & W.	B-17, Boeing	N5111N	—	One T34 in nose.
T34, P. & W.	YKC-124B, Douglas	51-072	2/2/54	One YKC-124B conversion. C-133A production.
T34, P. & W.	R7V-2, Lockheed	—	1/9/54	Two R7V-2 for U.S. Navy trials.
T34, P. & W.	C-121F, Lockheed	—	—	Two for U.S.A.F. trials
T34, P. & W.	KC-97J, Boeing	—	—	One with four T34.
T35, Wright	B-17, Boeing	44-85813	—	One T35 in nose.
T38, Allison	B-17, Boeing	—	—	One T38 in nose.
T38, Allison	Convairliner	N24501	29/12/50	Two T38; first U.S. commercial turboprop.
T49, Wright	YB-47D, Boeing	—	—	Not yet flown.
T50, Boeing	XL-19B, Cessna	52-1804	5/11/52	Only aeroplane with Boeing T50.
T51, Continental	XL-19C, Cessna	52-6311	—	Flown late in 1954.
T54, Allison	XF-84H, Republic	—	1954	One T54 in nose.
T56, Allison	B-17, Boeing	—	3/54	One T56 in nose.
T56, Allison	Constellation	N67900	1954	One T56, in outer starboard nacelle.
T56, Allison	YC-131C, Convair	—	20/5/54	Two T56. Two YC-131C conversions.
Marquardt ram jet	P-80A Lockheed	44-85214	—	One at each wing tip.
Marquardt ram jet	F-51D, North American	44-63528	—	One at each wing tip.
Marquardt ram jet	B-26 Douglas	—	1949	One 48-in. unit under fuselage.
N.A.C.A. ram jet	F-61, Northrop	42-39754	—	Aerofoil type, under fuselage.
N.A.C.A. ram jet	B-29, Boeing	45-21808	—	20-in. unit under fuselage.
N.A.C.A. ram jet	F-82, North American	44-83887	—	Ram jet drop missile under wing.

INDEX TO ENGINES

The following is a comprehensive index of all those jet engines, their manufacturers, and their aircraft installations covered in the history of jet engines on pages 11-31 inclusive. The reader will find the J and T lists of American engines particularly useful, and is also referred to the Data Tables on pages 32-36 inclusive, which are not indexed hereunder.

INDEX TO AIRCRAFT

All the aircraft mentioned in this book are covered in this index; where there are two or more entries, the reader is generally referred to the aircraft name under the constructor, and the first page number given there is the main entry. Test-beds and engine installations are indicated in italics in parentheses.